TEXAS HIGHWAY DEPARTMENT

Construction & Maintenance

BULLETIN No. 22

April, 1953

About the Cover . . .

The cover picture of a spot sealing job was made on U.S. 81 a few miles south of Austin in District 14. This work was under the supervision of Ruben F. Wallendorf, Senior Maintenance Foreman, and Joe Russell, District Maintenance Engineer.

The asphalt is being applied with an 800-gallon distributor. A spray bar is used to insure a uniformity of distribution and avoid lean and fat spots. The aggregate is spread by a shop-built, tail-gate-type spreader and is rolled thoroughly after being evenly spread. The aggregate used is similar to that in the original surface, so that it will blend with the existing pavement after a short period of time. A six- to eight-ton roller is being used.

These spot seals not only provide a smooth riding surface but also hold future damage caused by water and other elements of nature to an absolute minimum.

TABLE OF CONTENTS

Joint Cleaning Machine 3
E. D. Parmer
Tire-filling Device 5
Robert J. Milligan
New Sign and Paint Materials 6
Sam E. Roper
Penetration Surfaces 10
Gilbert A. Youngs
Eliminating Stresses 14
D. A. Nettleton
Inspection School 20
Meet the C&M Reporters 21
Spring Wild Flowers 24
Roy Rodman
Device for Retaining Tack Point While Placing R.O.W. Markers 26
J. H. Grissom
Traveling Scaffold Hangers 27
Asphalt Membranes 29
Frederick A. Harris
Over the Highways 40
Comments From the Traveling Public

Construction and Maintenance Bulletin

The purpose of the *Construction & Maintenance Bulletin* is to furnish a medium for presenting practical information applicable to current highway problems. These conclusions and data are not necessarily endorsed by the Highway Department nor are they to be construed as instructions. Employees are invited and urged to submit suggestions and relate experiences which would benefit those engaged in the construction and maintenance of highways.

Photographic services are available and other assistance may be obtained, if desired, in preparing material for submission. All material and comments should be directed to the Chief Engineer, Construction and Maintenance, Austin 14, Texas.

The *Construction & Maintenance Bulletin* is published monthly by and for State Highway Employees for departmental use only. The use or reproduction of the material contained herein is prohibited without the expressed permission of the State Highway Engineer.

PUBLISHED JOINTLY BY

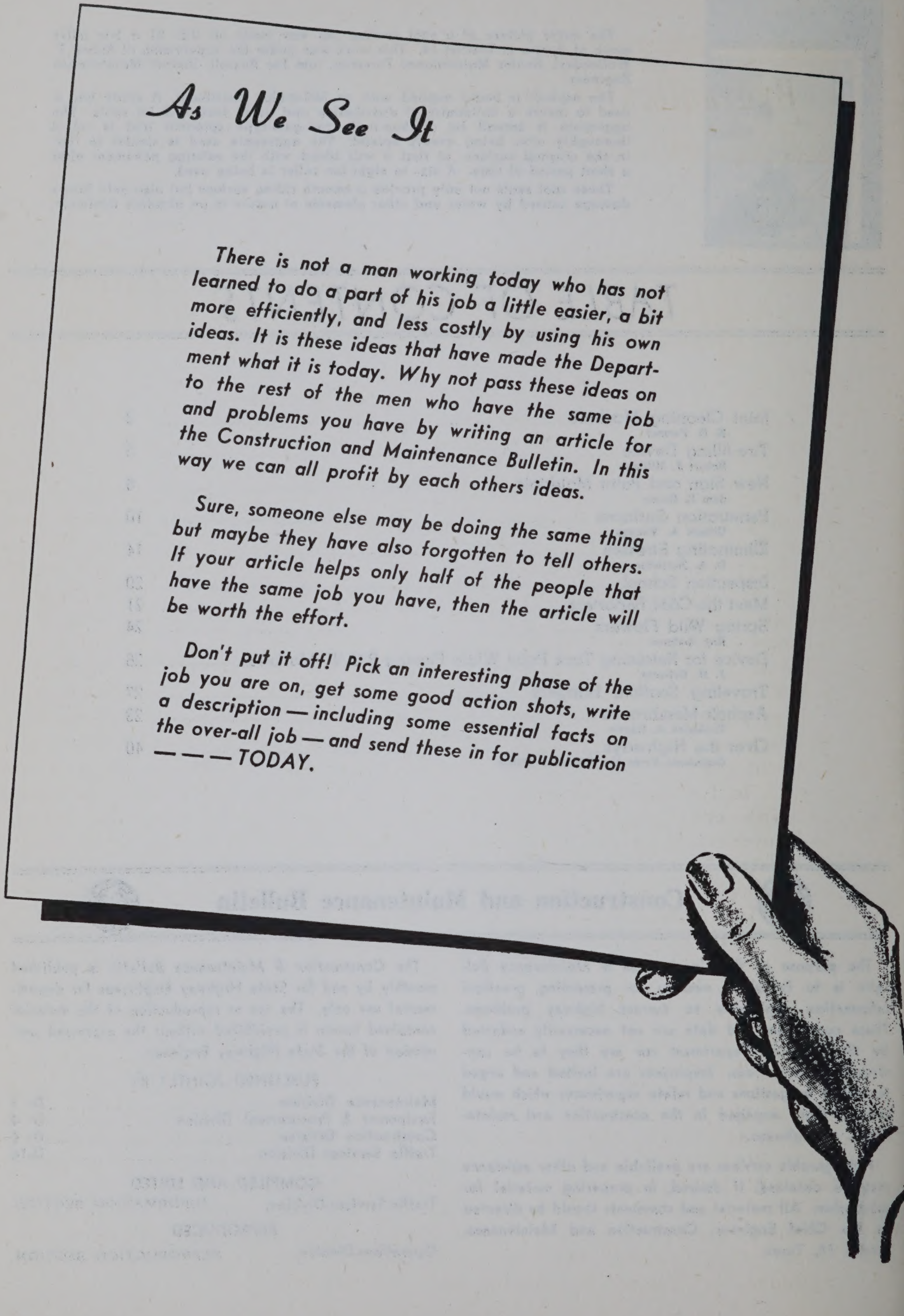
Maintenance Division .... D- 3
Equipment & Procurement Division .... D- 4
Construction Division .... D- 6
Traffic Services Division D-16

COMPILED AND EDITED

Traffic Services Division, INFORMATION SECTION

REPRODUCED

Operations Division, REPRODUCTION SECTION



As We See It

There is not a man working today who has not learned to do a part of his job a little easier, a bit more efficiently, and less costly by using his own ideas. It is these ideas that have made the Department what it is today. Why not pass these ideas on to the rest of the men who have the same job and problems you have by writing an article for the Construction and Maintenance Bulletin. In this way we can all profit by each others ideas.

Sure, someone else may be doing the same thing but maybe they have also forgotten to tell others. If your article helps only half of the people that have the same job you have, then the article will be worth the effort.

Don't put it off! Pick an interesting phase of the job you are on, get some good action shots, write a description — including some essential facts on the over-all job — and send these in for publication ——— TODAY.

Hydraulically Operated

JOINT CLEANING MACHINE

E. D. Parmer, Assistant District Engineer
District 20

A hydraulically operated joint cleaning machine mounted on a VAI Case Tractor was constructed in the District 20 shop by our shop employees under the supervision of O. A. Keith, Equipment Supervisor. This machine is now giving very satisfactory service in cleaning out expansion joints.

The point used to clean the joints is a Warco No. 10A-1013 scarifier tooth cut down to the thickness that is needed to fit the joint being cleaned and can be changed very quickly. The bracket that supports the tooth is made up to fit it. It is fastened in place with the Warco Wedge Keg No. 10A-1014. The tooth holder is welded to a 1-by-4-inch flat bar hinged at the draw bar at the back of the tractor. This hinge is built so the bar can hinge up, down, and sideways. There is a guide bar fastened to the side of the tooth holder to steady the tooth. This bar is hinged under the center of the tractor and will slide in or out and up and down, keeping the tooth from flopping around, but permitting it to follow the joint being cleaned.

The joint cleaner is raised and lowered by a Warco hydraulic leaning wheel, Cylinder No. 4E-3311. The cylinder is hinged at the top and bottom. It will swing in or out at any desired position. The bracket that supports the lift cylinder was built in our shop to fit the side of tractor where the case mower lift lever bracket fastens. This bracket was built out of 1-by-4-inch flat bar stock.

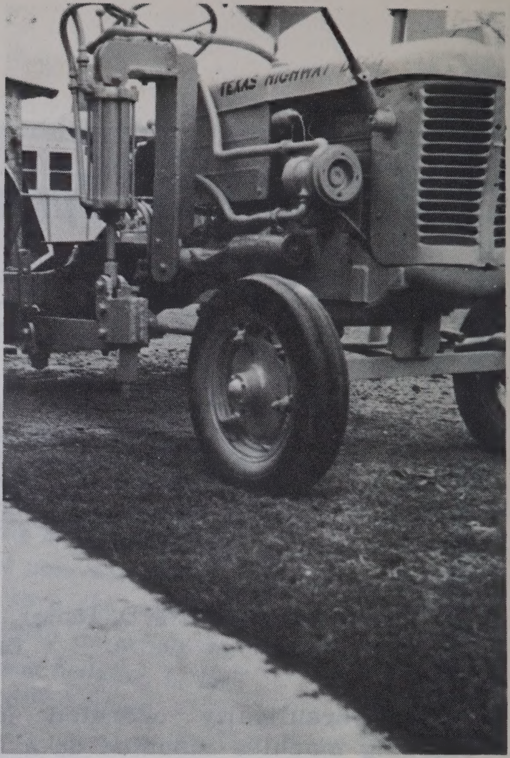
Picture 1 shows the hydraulic pump mounted on the right side of the motor. This is a Vickers Hydraulic Pump No. V-2111-C used on a Warco VD 900. This pump is pulled from the same pulley that the water pump is pulled from on the crankshaft; in fact, one belt pulls the water pump and hydraulic pump.

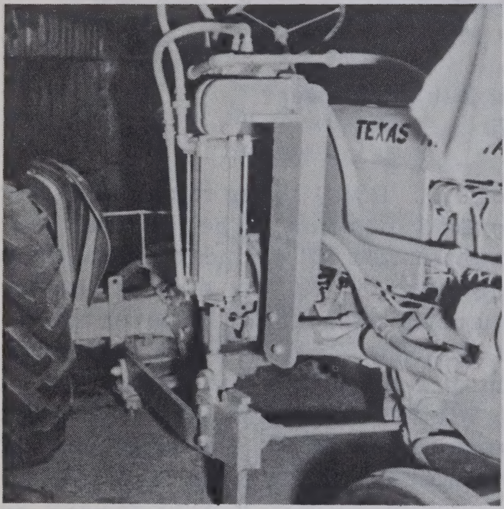
The station valve arrangement which operates the lift cylinder is shown in Picture 3. The hydraulic station valve used is a Drott No. GH-1320, Model 35 (TD-9 International). This valve is mounted on a bracket welded to the side of the bracket that supports the lift cylinder. There are five hydraulic hose plus the necessary pipe to hook the pump to the station valve and lift cylinder.

The hydraulic tank is a three-gallon tank (shop-built).

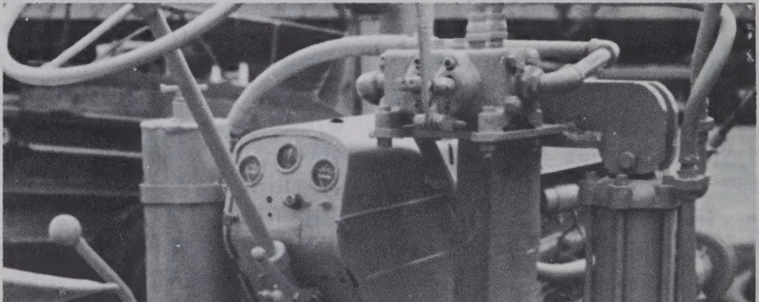
The hose consist of two Warcos No. 4E-11018, two Hubers No. BG-752 72 inches long, and one Huber No. BG-745.

Joint cleaner which is raised and lowered by a Warco Hydraulic Leaning Wheel Cylinder No. 4E-3311.





Bracket which supports tooth.



Hydraulic pump and station valve arrangements.

Tire-filling Device

Robert J. Milligan, District Engineer
District 23

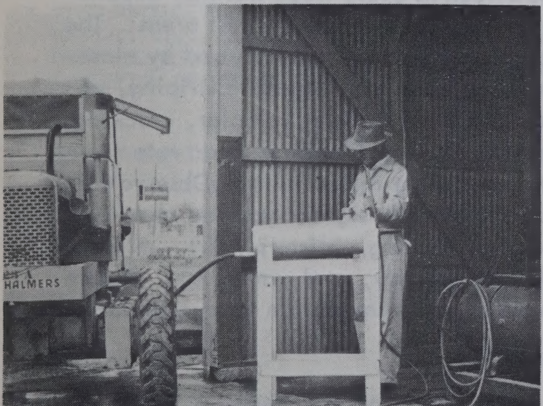
A method used for filling tires with water or antifreeze solution was devised by John Black, Senior Maintenance Foreman of McCulloch County. Black found ordinary methods for filling tires with liquids a tedious and long drawn out procedure so he came up with this very simple, yet very effective, device.

It consists of a section of eight-inch iron pipe, 30 inches long, with both ends closed by welding in steel plates. On the top is a section of two-inch pipe welded in for pouring the fluid into the cylinder fitted with a cap. The section of flexible hose is a standard commercial product with one end having a standard hose coupling and the other end having a standard connection for connecting to the valve stem. On top of the tank a valve stem has been welded into the tank enclosed in a section of one-inch pipe for protection. The capacity of this tank is approximately fifteen gallons of fluid.

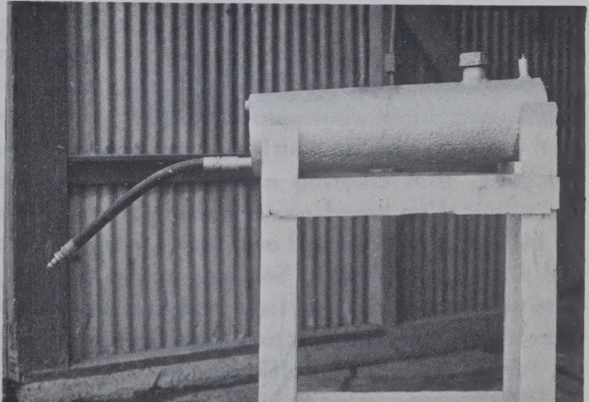
The fluid is poured into the tank. The flexible hose is connected to the valve stem of the tire, and approximately ten pounds of pressure are applied from the air compressor, forcing the liquid into the tire very quickly.

This is Black's experimental model, and he has several improvements that he will make on his next model.

(1) He will increase the size of the tank to hold ten gallons, approximately the capacity of a maintainer tire.
(2) He will place an air gauge on top so that he can better regulate the air pressure.
(3) He will put on a longer hose.
(4) He will make it portable by placing it on rollers similar to that of the air compressor.



Black demonstrates the simplicity of his device. The tank is filled with water and the hose is connected to the valve stem. Black is applying air pressure with the air hose.



A close-up showing the simplicity of construction. The wooden rack is merely a stand for the tank.

NEW SIGN and PAINT MATERIALS

Sam E. Roper, Traffic Designing Engineer
Traffic Services Division

Within the past few years the increasing demand for traffic paints and materials used for traffic signs has brought about a very troublesome and awkward situation in the purchasing of these materials. All materials are purchased by competitive bidding, and in the past one of the requirements usually has been that the product must be a certain brand or its equal. This places a very difficult responsibility upon the Department to determine whether the low bidder's product is equal to the brand called for in the bid. The only solution was long and expensive field and laboratory tests to determine the qualities of all brand-name paints. In order to alleviate this condition, it was decided that the Highway Department should develop specifications that would place the purchase of these materials on a strictly competitive bid basis, thus creating equal competition and eliminating brand-name products.

In 1949, the Materials and Tests Division and Division of Traffic Services began an extensive laboratory and field research program to develop satisfactory specifications for traffic paints and traffic sign materials. Field tests were carried on in various sections of the state to determine the behavior of the materials under all climatic conditions found in Texas. Many commercial products were tested to determine which of them were satisfactory for highway use. Once the better commercial brands were determined, the laboratory then set out to develop specifications that would be equal or better than the commercial brands tested.

Briefly the field tests were conducted in the following manner:

Traffic paints were applied and the traffic signs were constructed and erected in the identical manner in which regular striping and signing operations are conducted. No special procedures were followed. Regular inspections were made jointly by Files D-9 and D-16. These inspections ranged from once a week to every three months, depending upon the location of the test areas. The inspections were made visually and by close-up photographs. In regard to striping, observations were made as to color, cracking, checking, flaking, bleeding, bead retention, wear, and night reflectivity. Observations made of the traffic signs concerned checking, cracking, flaking, blisters, dirt, mildew, night reflectivity, and vandalism. Figure 1 shows a sample inspection form used during the tests.

As a result of the tests, in 1950 the Materials and Tests Division developed a specification for yellow traffic paint (YP-7) and white traffic paint (WP-7) which it was hoped would be equal to, and less expensive than, any of the commercial paints tested.

On September 26 and 27, 1950, (See

SIGNS AND STRIPING

SIGN NO. ~~STRIPE NO.~~ .... 1 .... DISTRICT .... 20 .... HIGHWAY .... U.S. 90 ....

INSPECTED BY .... S.E.R. .... MATERIAL .... Saftical ....

LOCATION .... 10 Miles East of Vidor ....

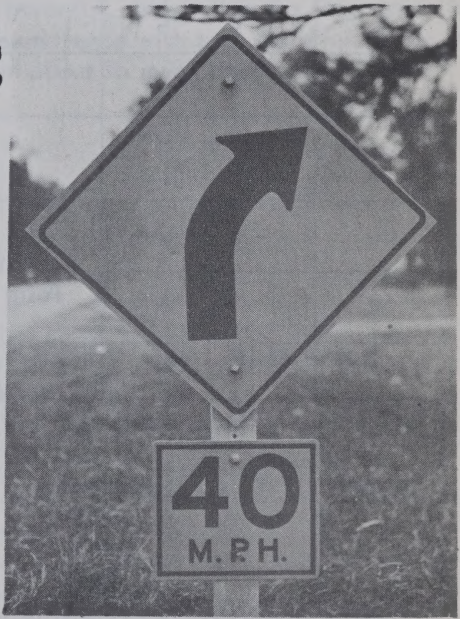
....

DATE .... 2-7-51 .... WEATHER .... Clear .... TIME .... 2:00 P.M. ....

1. SIGNS

REMARKS

CHECKING.............. Minor. Moderate. Major. [✓ None]
CRACKING.............. Minor. Moderate. Major. [✓ None]
FLAKING............... Minor. Moderate. Major. [✓ None]
BLISTERS.............. Few. Many. [✓ None]
DIRT.................. [✓ Little.] Much. None
MILDEW................ [✓ Minor.] Moderate. Major. None
NIGHT REFLECTIVITY.... [✓ Satisfactory.] Unsatisfactory
VANDALISM............. [✓ Minor.] Moderate. Major. None



II. STRIPING

SURFACE..
COLOR................Light. Medium. Dark. Very Dark
CRACKING.............Minor. Moderate. Major. None
CHECKING.............Minor. Moderate. Major. None
FLAKING..............Minor. Moderate. Major. None
BLEEDING.............Minor. Moderate. Major. None
BEAD RETENTION.......Poor. Fair. Good.
WEAR.................Little. Moderate. Much. None
NIGHT REFLECTIVITY...Satisfactory. Unsatisfactory
CONDITION OF STRIPE..Satisfactory. Unsatisfactory

Note: Circle condition that applies

FIGURE 1

TEST RESULTS
State Hwy. 20 (Now U.S. 290)

ORDER OF RATING	DURABILITY (Film)	NIGHTTIME REFLECTIVITY
1	"YP-7"	Paint "J"
2	Paint "F"	" "B"
3	" "E"	" "H"
4	" "B"	"YP-7"
5	Paint "G" " "J"	Paint "G"
6	" "L"	" "F"
7	" "D"	" "M"
8	Paint "H" " "I"	" "L"
9	" "M"	" "I"
10	" "A"	Paint "D" " "E"
11	" "K"	" "A"

FIGURE 2

Construction & Maintenance Bulletin No. 4, January 1951) a very detailed field test for traffic paints was begun in Austin and vicinity. Eight commercial paints, along with the newly developed YP-7 specification paint were placed as four-inch width stripes, side by side, at two separate locations. One site selected was Lamar Boulevard between Forty-second and Forty-third Streets. The other site was State Highway 20 (now U.S. 290), near the northeast city limits of Austin. A constant check was made of these stripes for about nine months for the Lamar Boulevard site and about eighteen months for the ones on State Highway 20. The results of the above-mentioned tests showed that YP-7 was equal to or better than any of the commercial paints in nearly all respects. Tests in other parts of the state also indicated that YP-7 was very satisfactory. A summary of the results of the Austin tests is shown in Figures 2, 3, and 4.

Field tests of the white traffic paint

TEST RESULTS
Lamar Blvd.

ORDER OF RATING	DURABILITY (Film)	NIGHTTIME REFLECTIVITY
* 1	"YP-7"	"YP-7"
2	Paint "I"	Paint "B"
* 3	"YP-7"	Paint "H"
4	Paint "F"	Paint "F" "YP-7"
5	Paint "B"	Paint "J"
6	Paint "E"	Paint "E" Paint "I"
7	Paint "L"	Paint "G" " "K" " "L"
8	Paint "H"	Paint "D"
9	Paint "G"	Paint "A"
10	Paint "D"	
11	Paint "J"	
12	Paint "K"	
13	Paint "A"	

* Two Samples of YP-7 were Tested

FIGURE 3

(WP-7) have not been as extensive as the tests of YP-7, but limited laboratory and field tests made thus far indicate that it, too, is a satisfactory specification paint.

With regard to the traffic sign tests, the tests included many types of sign materials such as steel, aluminum, plywood, masonite presdwood, and plastics. The greater emphasis was placed, not on the sign blanks themselves, but on the reflective materials used. Reflective sheeting, beads, binder, and reflector buttons of all leading manufacturers were tested. From the tests it was found that although in some cases beaded signs did not produce as good reflective qualities as some of the signs using reflective sheeting, the beaded signs were entirely satisfactory for highway use. They were by far the most economical.

In answer to the search for a satisfactory traffic sign bead-binder, the Department has developed a white bead-binder which now is undergoing field tests in Districts 11 and 14. Some of these signs are erected in the Luling area, where gas and sulphur fumes have previously created some additional difficulties in the problem of signing. The Materials and Tests Division at present is also working on a yellow bead-binder for traffic signs which should be ready for field testing in the near future. It is hoped that the final results of these tests will prove the paint binder a satisfactory material for reflectorizing traffic signs, which will eliminate the difficulty now being experienced in purchasing reflective materials.

In addition to the above tests, we are also experimenting with Fiberglas traffic signs in the Austin area. These signs were erected only recently, and as it is the Department's first experience with such material, little is known about its merit at present.

TEST RESULTS
Lamar Blvd.

PAINT	FILM THICKNESS	DATE PAINT BEGAN TO FAIL	DATE PAINT FILM BECAME UNSATISFACTORY	DATE PAINT FILM COMPLETELY FAILED
A	.027"	1 Month	3 1/2 Months	9 Months
B	.020"	2 1/2 Months	6 1/2 Months	Paint Film had not reached complete failure at time test was concluded
YP-7	.023"	3 1/2 Months	9 1/2 Months	
D	.026"	2 1/2 Months	6 Months	
E	.026"	2 1/2 Months	4 Months	
F	.023"	3 Months	7 1/2 Months	
G	.028"	2 1/2 Months	5 1/2 Months	
H	.029"	2 1/2 Months	6 1/2 Months	
I	.020"	3 Months	9 Months	
J	.024"	2 1/2 Months	5 1/2 Months	
K	.022"	2 1/2 Months	5 1/2 Months	
L	.021"	2 1/2 Months	6 1/2 Months	
YP-7	.032"	3 Months	7 1/2 Months	

FIGURE 4

Penetration Surfaces

Gilbert A. Youngs, District Engineer
District 19

For the past several years the Annual Highway Short Courses at Texas A. & M. College have had one or more papers dealing with "Penetration Surfaces" or with some of the problems peculiar to this type of construction.

All too often the average engineer brushes the remarks made on such a commonplace subject aside thinking his own methods are satisfactory, or that no method will ever satisfactorily solve the problems connected with this necessary evil. Other engineers recognize the urgent need for a change from the practices that have been followed, but balk at listening to, studying, or trying to follow a rational design which has been worked out because they may think it too theoretical, or at least of interest only from an academic point of view.

Last year at the Twenty-sixth Annual Highway Short Course, Senior Resident Engineer, J. P. Kearby of Decatur, Texas, delivered a paper "Thoughts and Theories on Penetration Surfaces." This paper was more than its name implies. It was and is one answer to the problem of design of penetration surfaces. The word "Theories" in the title of this paper scared off a number of the "old school" of engineers who still think that to theorize too deeply is a sign of weakness. The fact that leading construction magazines, The Asphalt Institute, Highway Research Board, and others have sought out Kearby for this comprehensive work indicates that it is not "just another theory."

The seal coats and single and double asphalt surface treatments which this District has placed in the past have been unsatisfactory from the standpoint of texture, uniform color, skidproofness, and flying stone. They have also been expensive because approximately 50 per cent more asphalt has been used for a given aggregate than should have been. This caused early bleeding, necessitating the addition of more stone. The bleeding could be stopped, ultimately, by this procedure after 10 to 35 per cent more aggregate was placed than could ever be "stuck," but the end product was scabby, rough, off color, and slick. The only desirable factor secured from such a seal coat is that it is waterproof.

Last summer we began by reducing the amount of asphalt from a 0.3 gallon per square yard to 0.25 and 0.2 gallon applications on an arbitrary basis. Grade 4 aggregate was being used and on some jobs .2 gallon was right, while others were better with .25 gallon. On some we got a good cover with aggregate at 1:100 while other jobs required 1:115 or 1:120.

It was decided to secure the average screen size or "mat thickness" and per cent of voids and compare our cut and try designs (which by the end of the job were looking good) with Kearby's design procedure. The agreement was amazingly close. The method was immediately adopted as our tentative procedure and our laboratory quickly performed the necessary tests on material stockpiled throughout the District. The basic design data in terms of rate of asphalt and aggregate was given to the foreman for each job, and if they differed materially, for each stockpile of aggregate.

If the base or pavement was normal, no change was made in the basic design. If a single was being placed on a prime coat which was fresh enough to contribute slightly to the available asphalt, a few hundredths was subtracted from the asphalt rate. If a seal was being placed on an old, badly cracked surface, a few hundredths of asphalt was added to the theoretical rate. Although this practice is recommended, it is believed a very good penetration surface would result if no such allowances were made at all. Since the basic principle of the design is to secure a mat of one-stone thickness, the foremen were advised to start with the basic design and then attempt to spread the aggregate farther so long as a good cover was secured. It was quite rare that a good cover could be secured with any less than the design amount. Never was any more aggregate required than the theoretical rate.

This procedure was used, not only in the work being done with our own forces, but also on contract projects. On one project we had specified 0.3 gallon of OA-135 with 1:100 of aggregate Type A, Grade 6. After analyzing the aggregate, we placed 0.17 asphalt and 1:140 aggregate. Naturally, we secured a thinner surface course than we wanted, but the rates of application were in proper balance and the only rates which should have been used with the size of aggregate furnished.

One point which should be clearly borne in mind is that it is necessary to determine the size and voids of the aggregate furnished. Grade 4 aggregate on the coarse side could require 0.3 asphalt and 1:75 whereas Grade 4 on the fine side could require 0.1 asphalt and 1:175. The specification limits are too broad.

It is recognized that the aggregate we receive is generally free from flat and elongated pieces. That is the reason the "average size" method of design has worked well in this District. In those instances where we noticed flat and elongated pieces in the aggregate, the spread could be increased considerably and the asphalt rate decreased proportionately. With this type of aggregate Kearby recommends that the square yard test board method be used. I am sure it will give more accurate results for this type.

In applying singles late in the season, RC-2 asphalt was substituted for OA-135 in exactly the same amount. It was assumed that the volatiles in the cutback would liven up about the same amount of asphalt in the prime or old surface. This is apparently what happened, and little difference was noticed between surfaces where these two types of asphalt were used.

The design data sheet was developed in this District for use in the basic design. This procedure differs from Kearby's only in the angle of approach. The formulas are designed to give the same results as Kearby's graphs and are based on his theory. This procedure appears in Construction & Maintenance Bulletin No. 11.

The penetration surfaces placed in this District last summer based on Kearby's design were rolled out in two or three days with two flat wheels where we had used four and five rollers before. A very large percentage of the aggregate placed was stuck and there was a very great decrease in observed "flying aggregate." No additional aggregate was required in curing other than minor spotting immediately after aggregate application. Prior to the use of this design method, we used from 10 to 35 per cent more aggregate after the first application, and sometimes many days of rolling before all bleeding was stopped. Needless to say, this operation was accompanied by many broken windshields.

It may be other Districts have not been experiencing the same trouble that we have. If not, you are fortunate. If you have had trouble, give Kearby's design a trial. You will find it easy to follow and that it will improve your work.

ASPHALT SURFACE TREATMENT

Cover Stone Spread Ratio and Asphalt Rate Computations

Project: Hwy.: County:

Sample No.________________Sp. Gr.______________Unit Wt.___________% Voids_____

Type_________________Grade__________Reps.______________ C.Y.______________

Percent Retained On Percent Passing

Sizes	1	7/8	3/4	5/8	1/2	3/8	1/4	#10	#20
Specification Accumulative Gradation Percent									
Average Accumulative Gradation Percent									

Average Individual Screen Analysis

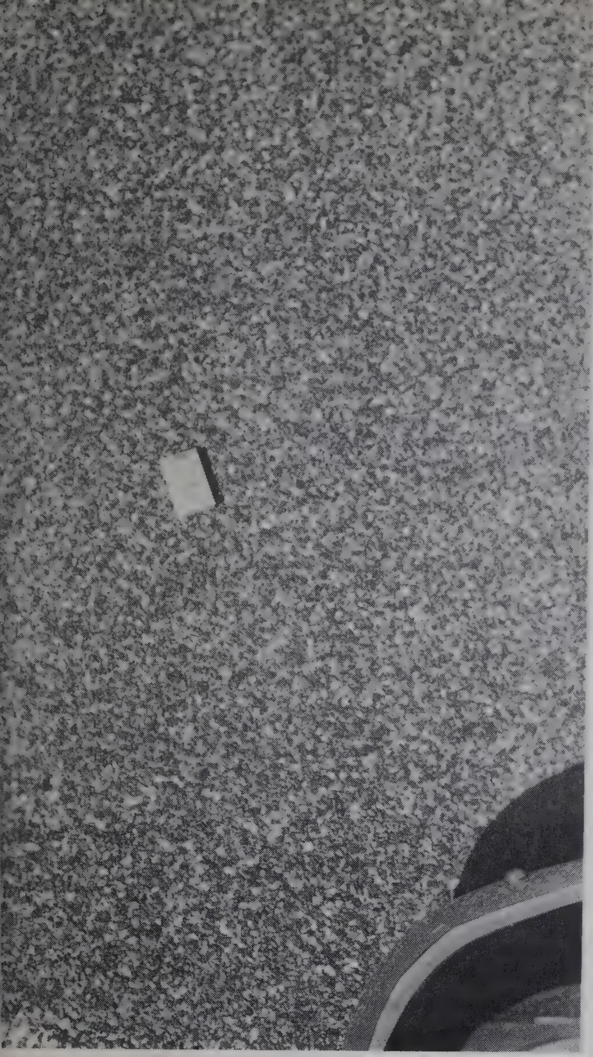
Sizes	7/8-1	3/4-7/8	5/ 8-3/4	1/2-5/8	3/8-1/2	1/4-3/8	#10-1/4	#10
Avg. Sizes	15/16	13/16	11/16	9/16	7/16	5/16	3/16	1/16
Percent								

Calculations for Average Particle Sizes of Aggregate and Effective Mat Thickness

Percent	Times	Average	Size
% x 15/16	=		/16
% x 13/16	=		/16
% x 11/16	=		/16
% x 9/16	=		/16
% x 7/16	=		/16
% x 5/16	=		/16
% x 3/16	=		/16
% x 1/16	=		/16

100 % Total /16 X 2 = = T (being the average size of Aggregate particles and also the Theoretical Mat Thickness for one stone cover expressed in 32nds of an inch).

Aggregate Spread Ratio = 1152 ÷ T =
Percent Embedment = T + 18
Asphalt Rate = $T \times \frac{\%\ \text{Emb.}}{100} \times \frac{\%\ \text{Voids}}{100} \times 0.175 =$ Gal/S.Y.



ELIMINATING

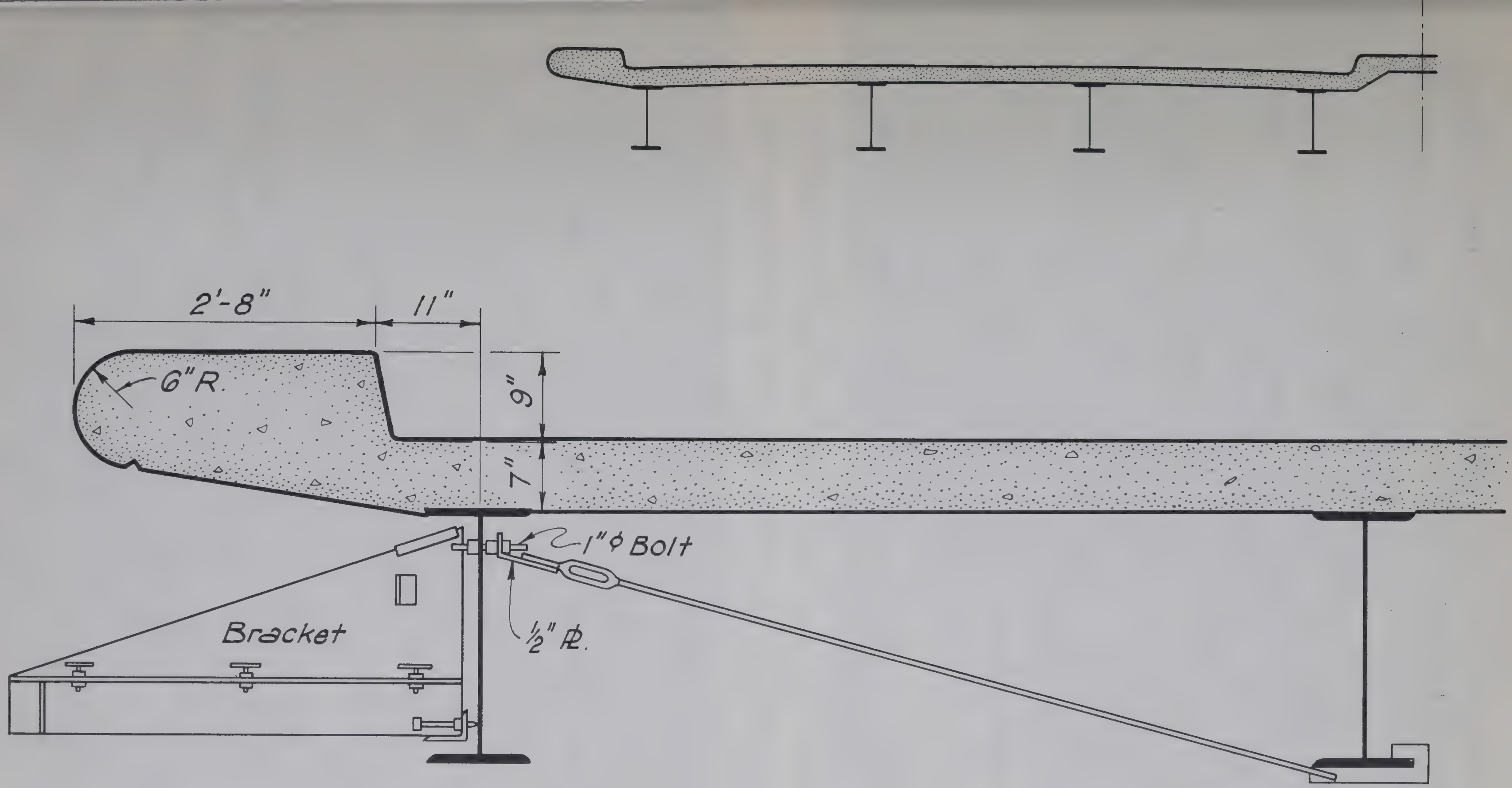
Stresses

D.A. Nettleton, Supervising Urban Engineer
Dallas Urban Project

Temporary steel brackets, connecting to the outside beam of steel beam bridges for the support of slab overhang forms, have been used for some time on Texas Highway Department projects. Unless these brackets are located opposite diaphragms, they produce torsional stresses in the outside beam. Figure 1 shows a steel bracket and overhang forms. A one-inch diameter stud bolt, welded to the web plate of the bracket, passes through a one and one-eighth-inch-diameter hole drilled in the web of the beam a little below the top flange. At the bottom of the bracket, two set screws pass through threaded holes in an angle welded to the bracket and bear against the beam web. These screws deliver the thrust of the bracket to the beam, and also permit adjustment of the bracket.

When Austin Bridge Company proposed to use these brackets on a Central Expressway four-lane-overpass structure, 1, 900 feet long with a slab overhang of 3 feet, 5 inches, an investigation was made of the beam stresses produced by these brackets. Figures 2, 3, and 4, are views of this structure.

A typical unit consists of beams continuous over five 42-foot, 7-inch spans. The superstructure is split into two parallel units by a longitudinal expansion joint down the center of the median strip. Each unit is supported by four lines of beams, 7 feet, 10 inches apart. The beams are 27 WF 94 with cover plates in the end spans. The maximum spacing of diaphragms is 16 feet, 9 inches. Channel shear connectors are welded to the top flanges of the beams in positive moment regions to reduce deflection by composite action of the beam and slab. The temporary brackets are ten feet apart, and carry a load of 5, 300 pounds with an eccentricity of two feet on the outside beam. If the brackets are connected in the usual manner, an external torque of 10, 600 foot-pounds is applied to the outside beam and must be transmitted by the beam to the adjacent diaphragms. The beam resists torsional moment in two ways, by pure torsional shear and by lateral bending of the two flanges in opposite direction. The stiffness of these beam flanges for a continuous horizontal span of 16 feet, 9 inches is so large in comparison to the pure torsional stiffness of the beam that practically the entire torsional moment is carried by the lateral bending of the flanges. When the bracket is located at the midpoint between diaphragms, the maximum stress in the beam flanges from horizontal bending



OVERHANG BRACKET DETAIL

DALLAS CO. U 61 832(9) C92-1-11 U. S. HWY. 75

amounts to 9,800 pounds per square inch. The maximum stresses occur at the edges of the flange with tension at one edge and compression of the same amount directly across the flange. Thus this stress from lateral bending will add directly to the stress from vertical bending at one edge of the flange. The stress in the beams from vertical bending during the period that the brackets are in place is small, since no large live load is permitted on the bridge, and the combined stress from horizontal and vertical bending is well within the allowable of 18,000 pounds per square inch.

Unfortunately, however, when the brackets are removed, the top flange of the beam is prevented from returning to its normal position by the slab. The bottom flange of the beam is free to return to its normal position except for a negligible amount due to the restraining action of the top flange transmitted through the web which is very flexible in a lateral direction. Even where there are no shear connectors and where the slab is haunched down to the beam flange, it is believed that the bond between the concrete and the beam flange may be sufficient to prevent the return of the flange to its normal position.

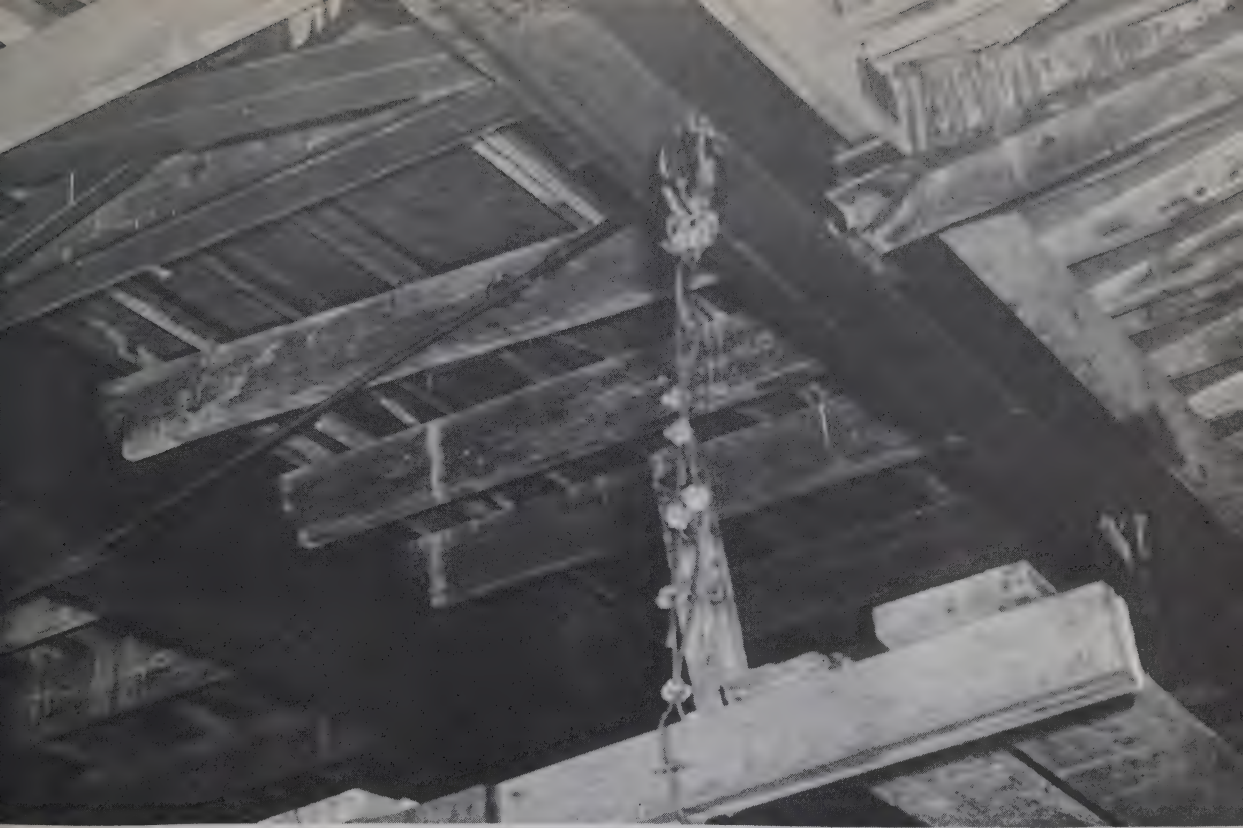
This "locked-in" stress in the top flange of the beam is in the nature of a secondary stress, similar to the secondary bending stresses which occur in riveted truss members. In truss members, secondary bending stresses up to 25 per cent of the primary stress are usually permitted. The secondary stress in this case amounts to 54 per cent of the primary stress. Furthermore, it is a stress that could be avoided entirely by the use in construction of cantilever beams, ordinarily called needle-beams, attached to the bottom flanges of the two outside beams for the support of the overhang forms. Since steel brackets have been permitted in the past, it was considered only fair to the contractor to try to work out a satisfactory scheme using these brackets.

The first thought was to tie the top flange of the first interior beam to the top flange of the outside beam at each bracket. If the two flanges are assumed to share equally in the load, the secondary stress in each beam would then be 27 per cent of the primary stress. However, no satisfactory tie connection could be worked out. Where the shear connectors are used, a straight reinforcing bar in the bottom of the slab could be welded to them to serve as a tie. Where the shear connectors are not used, the top flange of the beam is in tension and it was not considered permissible to use a welded connection. Any type of hook around the flange would go through the bottom form and was therefore not desired by the contractor.

Figure 5 shows the tie that was used. This tie transmits the horizontal pull from the bracket to the bottom flange of the first interior beam. A bent one-half-inch plate, welded to a seven-eighths-inch diameter turnbuckle, is used to attach the tie to the bracket bolt. The other end of the turnbuckle is welded to a seven-eighths-inch diameter reinforcing bar which, in turn, is welded to a hook made from a three-eighths-inch plate. This hook attaches to the bottom flange of the first interior beam.

This type of tie offered the opportunity of relieving the beams of practically the entire permanent secondary stresses induced by the bracket. By leaving the bracket bolt free to move horizontally in the hole through the outside beam web, practically the entire horizontal pull from the bracket would be transmitted to the bottom flange of the first interior beam. This flange is almost completely free to return to its unstressed position when the tie and bracket are removed.

The contractor desired to place a nut on the bracket bolt between the web of the outside beam and the bent



Overhang bracket and forms, and part of tie from bracket to lower flange of interior beam.

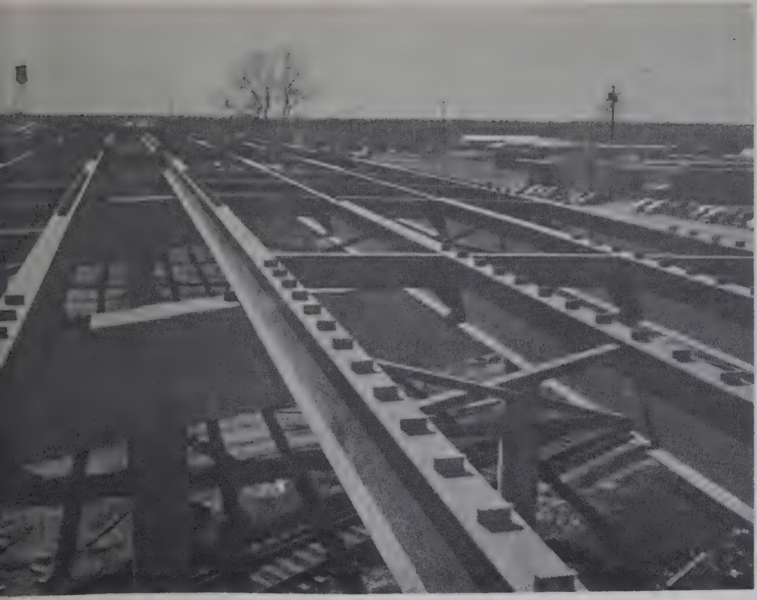
Aerial view of 1,900-foot, 4-lane structure. Note completed slabs and forms at right end.

plate connection of the tie. The purpose of this nut is to permit erection of the bracket and overhang forms before connecting the tie. It was first proposed that this nut should be backed off one-fourth inch after the tie had been connected. The contractor objected to this, however, on the grounds that a failure or large "give" in the tie would let the overhang forms down to such an extent that they could not be pulled back, and might even result in a collapse. It was then agreed that the nut would be left against the beam web, but that as the load came on the overhang the turnbuckle would be tightened so that the nut would be free at all times. It was easy to get at the tie from a movable, suspended scaffold which can be, seen in Figures 1, 4, and 5.

It was soon found that the tie was sufficiently strong and had practically no "give" under load. As a result on later pours, the nut adjacent to the beam web was backed off one-eighth inch before placing the concrete and no adjustment of the turnbuckle was made during the pour. At one of the ties, measurements of deflections were made by means of piano wires stretched tight between the diaphragms, and the ordinates between the piano wire and beam web were measured by calipers. The bottom flange of the first interior beam was found to have a horizontal deflection of 0.11 inches under full load. This agreed fairly closely with the calculated deflection, and the beam flange returned almost to its unstressed position when the tie was released. The bottom flange of the outside beam was found to have the same deflection, and it also returned almost to its unstressed position when the bracket was removed. Measurements of the movement of the top flange of the outside beam showed no deflection. In view of these observations, it was considered that the use of the tie had resulted in elimination of practically all of the permanent secondary stresses from the overhang brackets.

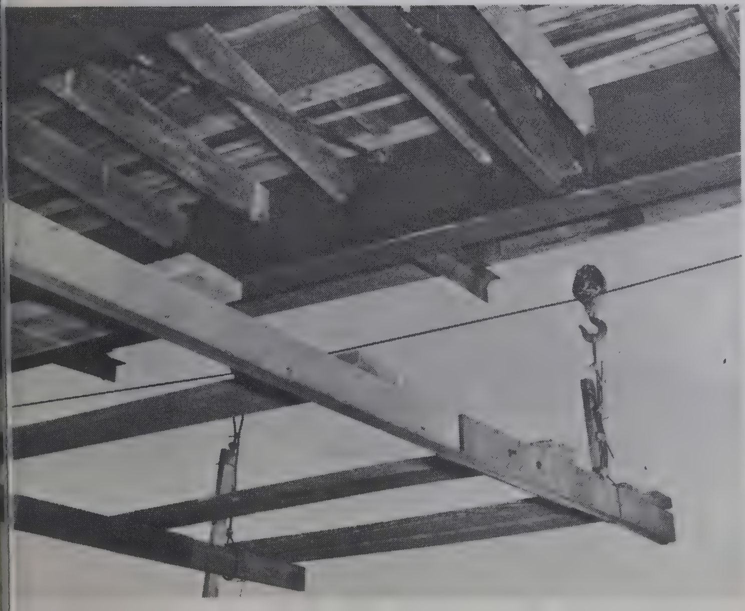
D-5 COMMENTS:

Brackets of this general type have been used by various bridge contractors for the last five years. When properly designed and used, they give results which please both the contractor and the engineer. Mr. Nettleton calls attention to the features which must be considered in investigating the proposed use of such brackets on any beam-span bridge. These are (1) the torque which must be resisted by the beam, (2) the spacing of permanent diaphragms between stringers, (3) the depth of the beams, (4) the dimensions of the beam flanges and (5) the location of the bracket with reference to the locations of the diaphragms. It will be an unusual case where such ties as these will be needed, but the decision should be made on the basis of an analysis of the stresses which are created. D-5 is available for the review of such form details.



View down center line of structure. Channel clips on beam flanges are to insure composite action between slab and beam to reduce deflection. Diaphragms are omitted between center beams due to longitudinal expansion joint along center of median strip.

Note unusually wide and thick slab overhang. Also note movable scaffold.



View of turnbuckle tie from overhang bracket bolt, which passes through a hole in web of outside beam, to lower flange of interior beam.

District 21 Reports

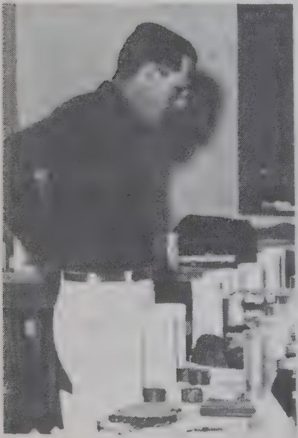
Inspection School Held

An Inspector's School for engineering personnel of District 21 was held in the evenings at the District Office in Pharr on February 24 and 26, and March 4 and 5. Classes began at approximately 8 P. M. and were dismissed around 10 P. M. Twenty-three attended.

J. F. Snyder, District Engineer, opened the school with a brief talk, explaining the purpose of the school and what he expected to accomplish. The school was ably conducted by June T. Martin, Senior Resident Engineer, and S. R. Busby, Assistant District Engineer.

Instructions covered Concrete Pavement, Earthwork and Flexible Bases, Surface Treatments and Cold Bituminous Mixtures, Hot Mix Asphaltic Concrete and Small Structures.

The men responsible for the school feel that it was a success. Snyder hopes to hold additional schools in the not-too-distant future. Great interest was shown by all those attending this school. Martin says for his part it was a pleasure and a good refresher course.



Professor June Martin.

District students.

437 of them...

Meet The C & M Reporters

C & M can probably lay claim to having the largest staff of reporters for any publication of its size. This distinction is a tribute to the cooperative spirit of the field personnel. Recently, each district reporter was asked to appoint an assistant reporter from each section and residency. The response was most gratifying. It clearly indicates the field's wholehearted support and endorsement of this medium of exchanging information for the betterment of the organization.

Below, for the first time, is a complete roster of the 437 field reporters. These men will be glad to offer assistance to you in preparing a story or discuss any ideas you have that might be beneficial to C & M.

District 1

Cravens, J. W., Reporter, Paris
Hutchison, A. D., Reporter, Paris
Barrett, W. B., Mt. Vernon
Brent, Floyd, Sherman
Burtner, B. P., Paris
Cagle, C. C., Sherman
Chism, B. D., Emory
Clark, Joe, Bonham
DeBerry, B. L., Greenville
Dickey, J. D., Paris
Dickey, O. D., Bonham
Fizer, Tom, Paris
Fry, Glen, Sulphur Springs
Hinkson, L. F., Paris
Jackson, R. A., Greenville
Johnson, T. A., Sulphur Springs
Mills, L. B., Emory
Moore, G. L., Clarksville
McCormack, L. A., Cooper
Short, H. H., Cooper
Walker, C. L., Paris
Watson, D. R., Clarksville

District 2

Potter, W. W., Reporter, Ft. Worth
Auvenshine, J. R., Decatur
Bingham, Joe M., Mineral Wells
Brown, R. A., Weatherford
Clark, J. A., Mineral Wells
Clay, E. C., Weatherford
Crook, R. W., Ft. Worth
Davis, Billie E., Jacksboro
Ferguson, J. C., Jacksboro
Geye, F. N., Granbury
Green, Jack, Ft. Worth
Jones, L. E., Stephenville
Kelley, Floyd J., Ft. Worth
Mercer, J. R., Jr., Decatur
Miller, Sidney, Ft. Worth
Robinson, Otis L., Cleburne
Stalcup, R. L., Cleburne
Stone, J. R., Stephenville

District 3

Morris, L. E., Reporter, Wichita Falls

District 3 (cont.)

Brooks, Paul, Throckmorton
Cooper, Cleo, Wichita Falls
Cox, C. D., Archer City
Eggleston, Holland, Gainesville
Farmer, H. C., Graham
Garrett, O. W., Wichita Falls
Hobbs, Charlie A., Seymour
January, A. D., Wichita Falls
King, J. E., Seymour
Nelson, Martin, Wichita Falls
Partridge, L. S., Bowie
Plummer, R. O., Vernon
Raabe, Martin L., Vernon
Simpson, John C., Gainesville
Southerland, T. H., Graham
Tucker, Loyd, Bowie
Watkins, C. C., Henrietta

District 4

Smith, C. W., Reporter, Amarillo
Best, Miss Eunice, Amarillo
Brown, Carl, Gruver
Clanton, H. E., Amarillo
Crandall, Richard, Amarillo
Harris, J. M., Amarillo
McGee, V. J., Borger
Reese, Byron, Amarillo
Riney, W. A., Clarendon
Trussell, H. D., Amarillo

District 5

Willson, J. D., Reporter, Lubbock
Anthony, Earl E., Brownfield
Brown, Herschel, Plainview
Campbell, Clay, Ralls
Clements, W. H., Muleshoe
Crawley, T. V., Lamesa
DeShazo, H. E., Lubbock
Dobbins, R. B., Lubbock
Edmonds, H. C., Littlefield
Ferguson, Mariese, Tulia
Garrett, W. H., Littlefield
Hart, Carl R., Brownfield
Ivy, William I., Levelland
Ogle, F. B., Lubbock

District 5 (cont.)

Partain, A. W., Lamesa
Patterson, Weaver, Seminole
Potts, James F., Floydada
Rogers, R. D., Dimmitt
Stanley, F. C., Lubbock
Weaver, H. C., Plainview
Webb, Jack, Post
Webber, Sanford, Floydada

District 6

Coleman, Paul H., Reporter, Pecos
Bates, Ben L., Midland
Beauchamp, Brawley, Pecos
Bevers, C. S. Jr., Odessa
Bull, C. C., Pecos
Dick, K. E., Sanderson
Douglas, J. H., McCamey
Duckworth, K. E., Midland
Gardner, Robert J., Andrews
Hardy, Clyde M., Odessa
Harral, Wm. R. Jr., Ft. Stockton
Hart, Harry E., Midland
Kelley, W. E., Pecos
Surratt, Harold L., Sanderson
Valentine, Jack V., McCamey
Wallace, H. S., Pecos
Ward, R. E., Monahans
Warnock, R. A., Ft. Stockton
Youngblood, W. L., Pecos

District 7

Willis, L. K., Reporter, San Angelo
Bailey, H. L., Big Lake
Butler, Jim, Sterling City
Carlton, D. N., San Angelo
Fields, Hubert, Junction
Hardeman, W. N., Junction
Hopewell, W. H., San Angelo
Houston, Scottie, Ozona
Itz, Felix, Ballinger
Jennings, A. J., San Angelo
Largent, H. P., Ballinger
Loeffler, S. M., Sonora
Pierce, Henry, Eden
Roe, Everett, Barnhart

District 7 (cont.)

Stroud, C. C., Sonora
Vannoy, Walter, San Angelo

District 8

Smith, Geo. J., Reporter, Abilene
Anderson, Z. H., Roby
Bollinger, Winifred, Baird
Bruton, Joe, Baird
Caldwell, Tom, Snyder
Carman, D. L., Aspermont
Conklin, C. A., Abilene
Copeland, Morris, Colorado City
Curtis, Rondal, Anson
Daugherty, R. L., Abilene
Landers, Eldon R., Anson
Landrum, H., Abilene
Logsdon, Paul H., Gail
Lusk, R. R., Haskell
Matthews, Erick Jr., Abilene
Middlebrooks, H. H., Merkel
Moore, H. W., Aspermont
McComb, S. A., Big Spring
Pierce, J. E., Snyder
Reed, Harvey W., Jayton
Seabourn, Bill, Abilene
Sharp, Selby S., Hamlin
Smauley, F. A., Sweetwater
Smith, D. P., Abilene
Wilson, H. D., Albany
Windham, N. P., Colorado City

District 9

Snell, J. A., Reporter, Waco
Aiken, J. H., Hamilton
Brown, Joe T., Belton
Evans, Elton B., Groesbeck
Hensler, Paul T., Gatesville
Jones, Otha, Waco
Ledbetter, J. P., Waco
Malone, M. L., Marlin
Neubauer, John, Waco
Nichols, J. W., Waco
Odell, Jack D., Waco
Ralph, T. H., Clifton
Word, Claud H., Hillsboro

District 10

Crutcher, I. H. Jr., Reporter, Tyler
Allen, John R. Jr., Tyler
Balfour, Burette H., Athens
Bass, Gilbert, Longview
Bradford, R. M., Longview
Carter, L. C., Mineola
Crow, Joe, Tyler
Dike, Ray, Palestine
Donohoe, G. M., Mineola
Frazer, D. V., Henderson
Harris, W. D., Rusk
Lee, R. L., Athens
Monroe, W. R., Tyler
McBride, T. A., Tyler
Renshaw, R. R., Palestine
Rix, Sam, Jacksonville
Rousseau, D. D., Henderson
Shaw, J. E., Canton
Sides, Jack, Canton
Simmons, Loarn, Rusk

District 11

York, J. M., Reporter, Lufkin
Barington, Lewis, Livingston
Chandler, Prentiss, Lufkin
Crowe, James R., San Augustine
Galloway, Frank D., Livingston
Harlan, H. V., Crockett
Hayes, Tracy, San Augustine
Hoskins, T. O., Crockett
Hubbert, L. H., Lufkin
Melton, H. H., Lufkin
Merchant, D. B., Lufkin
Pickard, A. V., Bronson
Ralph, Tom B., Center

District 11 (cont.)

Richardson, A. D., Shepherd
Rothe, R. L., Lufkin
Rudd, W. B., Center
Safley, D. S., Lufkin
Stockton, W. L., Lufkin
Swift, Luther Jr., Nacogdoches
Warren, Rufus, Nacogdoches
Womack, W. O., Groveton

District 12

Carmichael, W. E., Reporter, Houston
Ashburn, J. D., Houston
Aukerman, E. L., Bellville
Baker, J. L., Angleton
Burkett, Fred, Houston
Caldwell, P. H., Houston
Callihan, G. W., Dickinson
Coddou, Gene, Houston
Cooper, B. W., Conroe
Doss, J. H., Angleton
Gilbert, S. P., Houston
Gray, J. W., Alvin
Griffith, J. S., Hempstead
Hoke, R. I., Bay City
Hoke, Seth, Conroe
Miksovsky, F. G., Angleton
Rader, O. I., Houston
Rankin, Herman, Rosenberg
Riney, Claude, Houston
Roane, R. T., Rosenberg
Self, Ralph D., Houston
Stephenson, J. L., Pasadena
Vyvial, John R., Hitchcock
Werneburg, W. L., Hempstead
Willrodt, Wm. Jr., Bellville

District 13

Veazey, H. C., Reporter, Yoakum
Johnson, Zay, Reporter, Yoakum
Bain, J. B., Wharton
Botard, Herman, Hallettsville
Bushong, P. D., Gonzales
Effenberger, E. J., Edna
Fritsch, Anton, Cuero
Halliburton, D. B., Port Lavaca
Hunter, W. C., La Grange
King, W. A., Victoria
Koss, V. J., Columbus
Krause, H. P., Yoakum
Marling, O. G., Victoria
Patrick, W. L., La Grange
Sheppard, A. J., Columbus
Sladczyk, Otto, Yoakum
Smith, C. R., Gonzales
Templin, Max, Edna
Vaughan, C. H., Wharton

District 14

Hook, Don, Reporter, Austin
Crow, Maury, Giddings
Davis, C. J., Lockhart
Gibbs, Neil, Llano
Long, Travis, Austin
Schnerr, S. H., Fredericksburg
Schultz, Bill, Austin
Schulz, Lawrence, Austin
Staples, Jack, Burnet
Wallendorf, Reuben, Austin

District 15

Vordenbaum, Alton, Reporter, San Antonio
Atkinson, Claude, Pleasanton
Braunig, Carl Jr., San Antonio
Clements, J. S. Jr., Pearsall
Jordan, M. D. L., San Antonio
Littleton, W. C., San Antonio
Stotzer, Raymond, Hondo
Van Houten, F., New Braunfels
Wood, B. R., Floresville
Wood, C. G., Kerrville

District 16

Foster, T. O. Jr., Reporter, Corpus Christi
Anderson, B. E., Corpus Christi
Barnett, L. M., Sinton
Klaeser, J. H., Rockport
Lopez, A. D., Goliad
Mahoney, L. M., Alice
McFarland, R. J., Beeville
McKinney, Ray, Kingsville
Puckett, Herbert, Karnes City
Pugh, W. F., George West
Schneeman, H. Jr., Corpus Christi

District 17

Hogan, D. L., Reporter, Bryan
Crain, O. L., Bryan
Schleider, R. H., Bryan
Sloan, J. O., Caldwell

District 18

Green, Grover, Reporter, Dallas
Calvin, E. B., Dallas
Cole, Kenneth H., McKinney
Davis, S. D., Dallas
Dooley, A. J., Corsicana
Duree, A. F., Denton
Dyess, W. O., Waxahachie
Farley, A. L., McKinney
Gilder, R. E., Dallas
Grann, Henry Robert, Dallas
Greene, J. H., Corsicana
Harper, W. A., Kaufman
Henry, Arthur, Rockwall
Hodges, Alton Melford, Dallas
James, C. A., Ennis
Mann, G. B., Dallas
Olson, D. L., Kaufman
Orr, Harold A., Denton
Rainwater, A. E., Dallas
Reglin, Frederick Jr., Waxahachie
Shoemaker, S. A., Ennis
Smith, Melvin L., Dallas
Smith, T. A., Dallas
Wilcoxson, A. G., Kaufman

District 19

Frank, B. L., Reporter, Atlanta
Calloway, Dick, Gilmer
Chambers, C. D., Mt. Pleasant
Crawford, J. H., Mt. Pleasant
Dell, Charles W., Atlanta
Ellard, E. B., Linden
Fite, Ellis, Carthage
Gibbons, J. H., Marshall
Gullion, Guy, Atlanta
Hunter, T. G., Carthage
Ingram, T. B., Gilmer
Lindsey, C. H., New Boston
Lovil, W. C., Marshall
Pilant, L. T., Atlanta
Rideout, T. R., Jefferson

District 20

Parmer, E. D., Reporter, Beaumont
Airhart, E. A., Beaumont
Batey, R. W., Orange
Bean, H. M., Beaumont
Bellair, N. L., Orange
Bennett, R. M., Sabine Pass
Bythewood, Roy W., Silsbee
Campbell, Charles S., Beaumont
Carlton, T. A., Beaumont
Collins, Bud, Silsbee
Copp, Stirling W., Beaumont
Cortez, A. J. Jr., Port Arthur
Davis, James S., Beaumont
DeLacie, John, Beaumont
Dudley, Warren N., Beaumont
Ebarb, Jessie, Beaumont
Fuller, W. H., Voth
Gilley, Dennis, Beaumont
Greer, J. H., Cleveland
Hajousky, S. J., Dayton

District 20 (cont.)

Hamm, B. S., Beaumont
Holton, N. F., Woodville
Humphries, J. H., Winnie
Ivy, Reuben, Jasper
Johnson, Sidney, Beaumont
Kelley, Wiley B., Beaumont
Kieschnick, Harry, Port Arthur
Morris, J. O., Beaumont
McNamara, T. W., Orange
Nelson, Miss Disa Marie, Beaumont
Peltier, N. J., Sabine Pass
Perdue, J. M., Beaumont
Pfleider, Fred, Winnie
Self, John D., Beaumont
Smith, H. P. R., Jasper
Smith, Henry T., Anahuac
Steed, Warren B., Liberty
Stephenson, C. N., Liberty
Suter, W. E., Jasper
Trahan, John D., Silsbee
Williamson, R. S. Jr., Port Arthur
Windham, Cecil A., Orange
Woods, Jim, Newton

District 21

Busby, S. R., Reporter, Pharr
Apperson, W. J., Laredo
Guerra, Reuben R., Rio Grande City
Haddock, Carl N., Pharr
Haliburton, Tracey, Pharr
Houston, Geo. A., San Benito
Martin, J. T., Pharr
Moon, D. D., San Benito
McMullin, R. A., Falfurrias
Pile, E. W., Pharr
Robinson, H. O., Raymondville
Thornton, O. W., San Diego

District 22

Parsons, C. N., Reporter, Del Rio
Batchelor, C. W., Eagle Pass
Brooke, George, Carrizo Springs
Brown, G. P., Del Rio
Campbell, Clarence, LaPryor
Clark, Fred W. Jr., Carrizo Springs
Cox, R. S., Leakey
Cummins, L. G., Uvalde
Mangum, C. D., Del Rio
Roe, Bayles, Rocksprings
Sanders, Edwin L. Jr., Uvalde

District 23

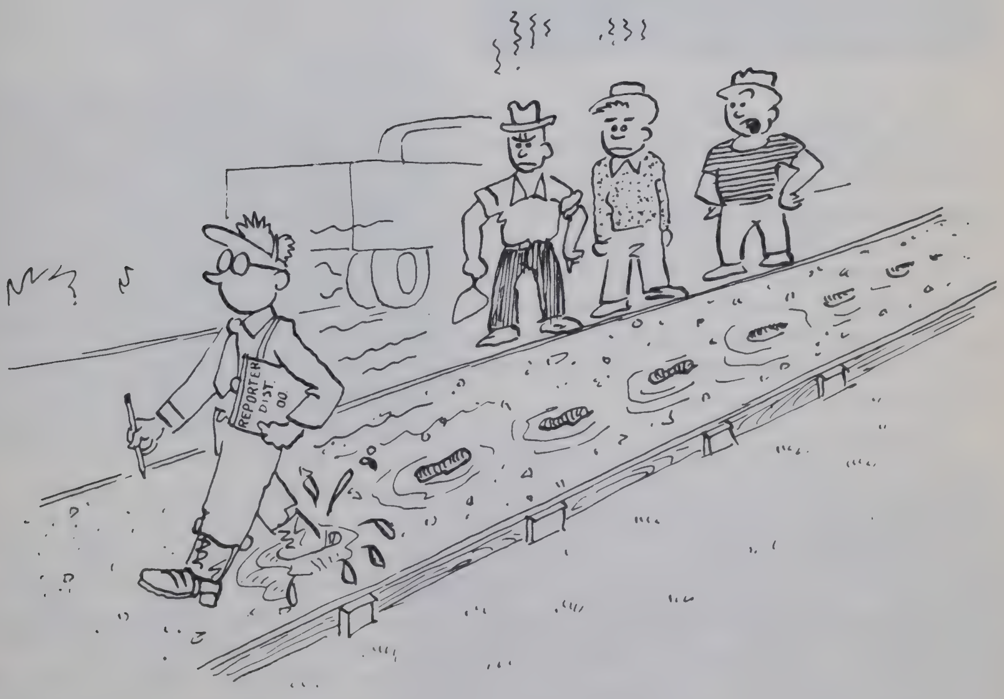
Pritchard, E. M., Reporter, Brownwood
Arthur, John M., Lampasas
Black, John E., Brady
Brannan, J. B., Breckenridge
Brookshire, Raymond E., Coleman
Cleveland, L. C., Brownwood
Dillon, Ben E., Brady
Huntington, P. R., Comanche
James, Wade H., Lampasas
Lewis, Harvey L., Eastland
Mayo, Erle, Coleman
Munsell, Dean, Breckenridge
McCarroll, Porter, Comanche
Smith, G. L., Eastland
Smith, Thos. W., Brownwood
Summy, Walter, Goldthwaite
Trotter, Glen G., San Saba
Trotter, Henry, San Saba

District 24

Moore, Max W., Reporter, El Paso
Bounds, B. B., Alpine
Brown, M. K., Marfa
Clendenon, R. R., Van Horn
Harrison, L. B., El Paso
Karber, C. P., Sierra Blanca
Karber, T. R., El Paso
Lane, Dale, El Paso
Miller, Norman, Alpine
McNew, J. D., Ft. Davis
Perez, Nicolas, El Paso

District 25

Massey, Palmer, Reporter, Childress
Bartley, Howard W., Quanah
Byrd, H. S., Memphis
Cumbie, J. J., Dickens
Cunningham, H. T., Munday
Doshier, Douglas R., Childress
Drake, Clyde, Wellington
Favor, W. V., Quanah
Gresham, C. E., Childress
Groves, Algie, Matador
Hamm, W. O., Childress
Long, J. R., Childress
McDonald, Wm. E., Wellington
Nabers, Robert L., Childress
Ray, W. B., Benjamin
Reynolds, John C. Sr., Matador
Smoot, Roy W., Childress
Taylor, Jack F., Shamrock
Thomson, J. A., Paducah



"Guess we'd better not say anything till we find out just what that reporting job of his covers!"

SPRING WILD FLOWERS

Roy Rodman
Supervising Landscape Architect
Traffic Services Division

Numerous inquiries are received in the Main Office requesting information regarding flowering periods and locations where wild flowers can be seen in Texas. Evidence of the public's desire to see these native flowers is found in the large number of people annually attending the various established flower festivals and trails.

The highway right of way is fast becoming a sanctuary for many of our colorful native plants. Many of these native flowers are established on the right of way by seed being transported either by wind, water, birds, animals, or vehicles. Several of the most desirable varieties have been planted or distributed on the right of way by our maintenance personnel.

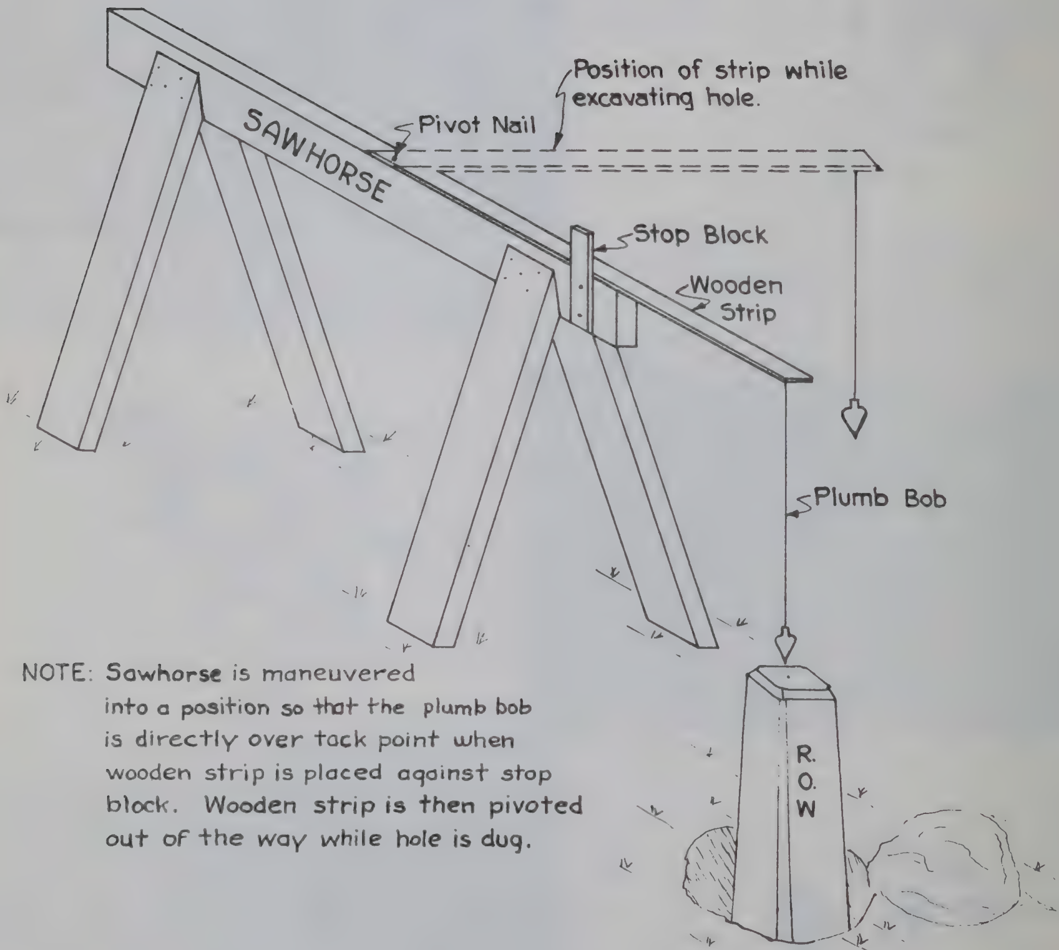
Because of climatic conditions, probably the most vivid array of color is found in the annual spring-blooming wild flowers. Many people drive long distances to see this display of color. In order to assure a display of flowers each spring, it is absolutely necessary that they be permitted to mature their seeds.

Maintenance operations make it necessary to limit the growth of wild flowers to the ones that bloom in the spring. Some years, because of weather conditions, even these early varieties may be a little late in maturing their seeds, making it necessary to defer mowing the right of way for two or three weeks. Should it become necessary for safety to cut tall grasses and flowers before the seeds have matured, it is suggested that the mowing be limited to the shoulders and those areas essential in providing sight distance for signs, guard posts, culverts, and bridges. The only protection needed to assure proper development and reseeding is allowing these wild flowers to mature seed before mowing, permitting the seeds to shatter on the right of way by leaving the clippings in place to dry, and preventing burning of the roadsides.

It is not possible to set any definite date on which mowing the right of way should begin, as the maturity of the seeds will vary according to weather conditions. An occasional check on the development of the seed is necessary to determine when they are ready to harvest or mow. The landscape advisers can be of assistance in helping to determine this date. As a general rule, for each fifteen miles northerly, the maturity date is one day later.

A DEVICE FOR RETAINING TACK POINT WHILE PLACING R.O.W. MARKERS

J.H. Grissom, Junior Inspector
District 20

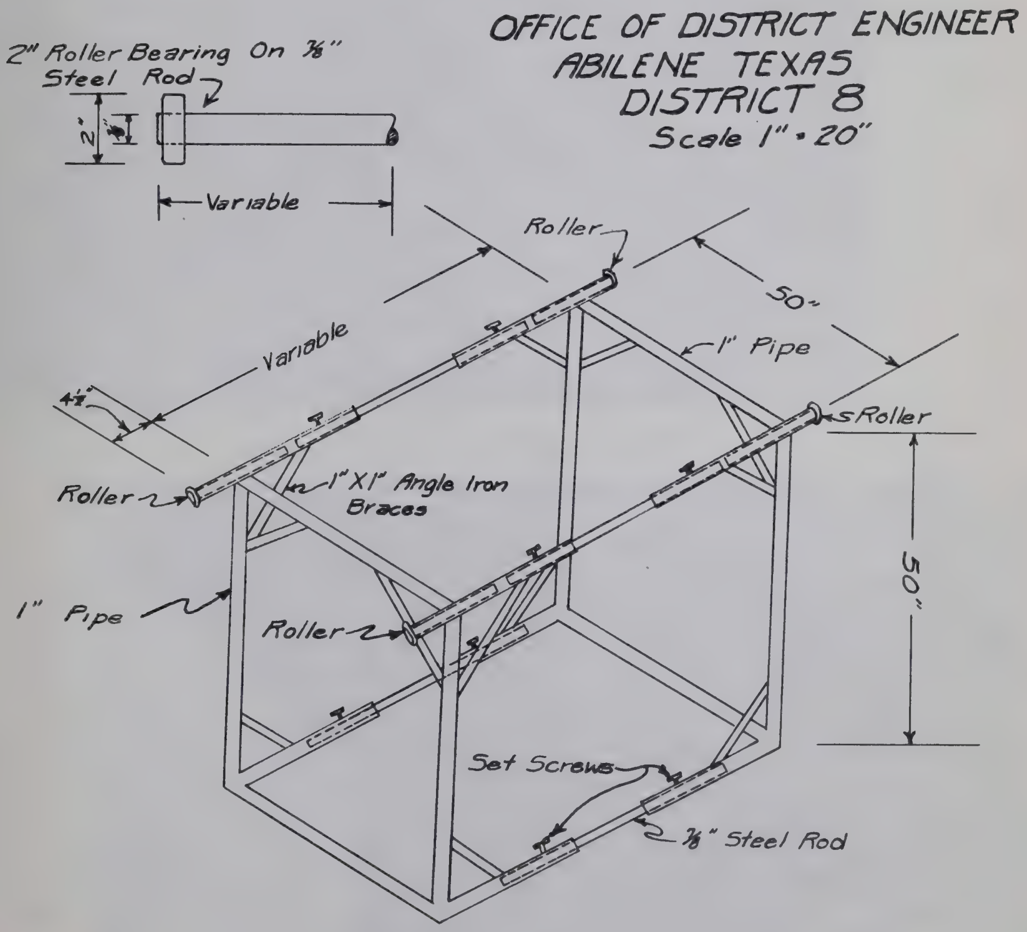


NOTE: Sawhorse is maneuvered into a position so that the plumb bob is directly over tack point when wooden strip is placed against stop block. Wooden strip is then pivoted out of the way while hole is dug.

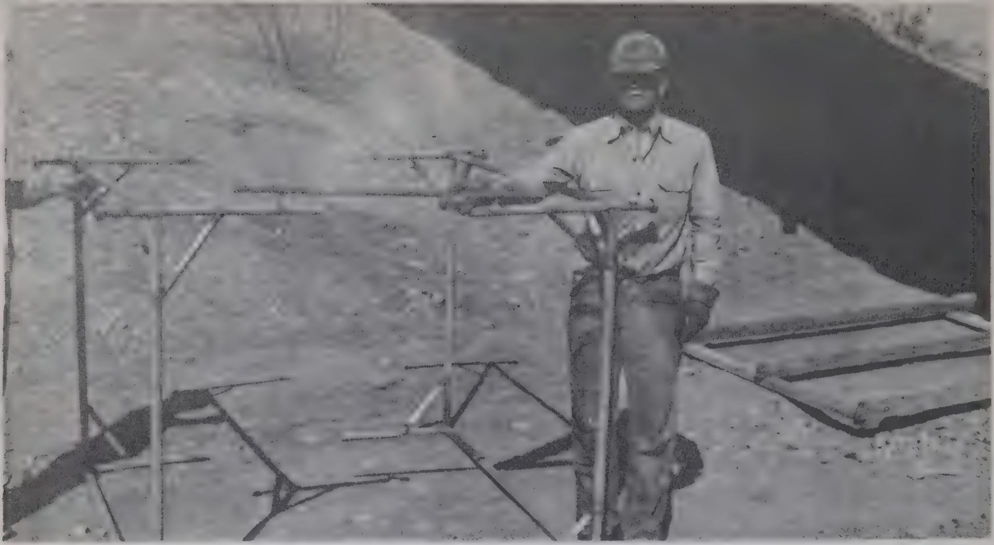
Traveling Scaffold Hangers

Submitted by District 8

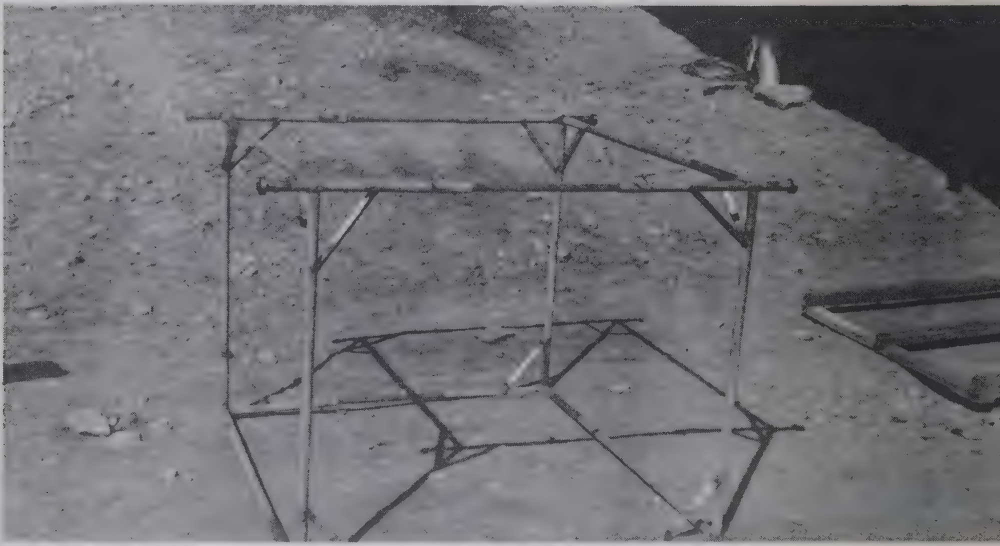
District 8 has developed a lightweight scaffold hanger which is adjustable in width and is supported by rollers on the bottom flanges of two adjacent stringers. The following sketch and pictures show the ease with which the hanger can be transported, assembled, and moved along a span. J. C. Roberts, District Engineer, reports that the scaffold has eliminated considerable time, labor, and material which were necessary when other scaffold arrangements were used for their jobs.



TRAVELING SCAFFOLD HANGERS



Scaffold hanger is light weight and portable.



Hanger assembled on the ground.

Hanger in place supporting scaffold and painters.

Asphalt Membranes

Frederick A. Harris
Senior Designing Engineer
Houston Urban Project

SYNOPSIS

All earth fills for Gulf Freeway bridge abutments have central core sections completely enclosed in asphalt membranes. Approximately two miles, or 380,000 cubic yards, of embankment are involved. This policy was established by W. J. Van London, Engineer-Manager, with a view to preventing the disastrous effects of moisture fluctuations in clay soils frequently observed in this vicinity. It was considered essential that fills be constructed in such a way as to require little or no maintenance.

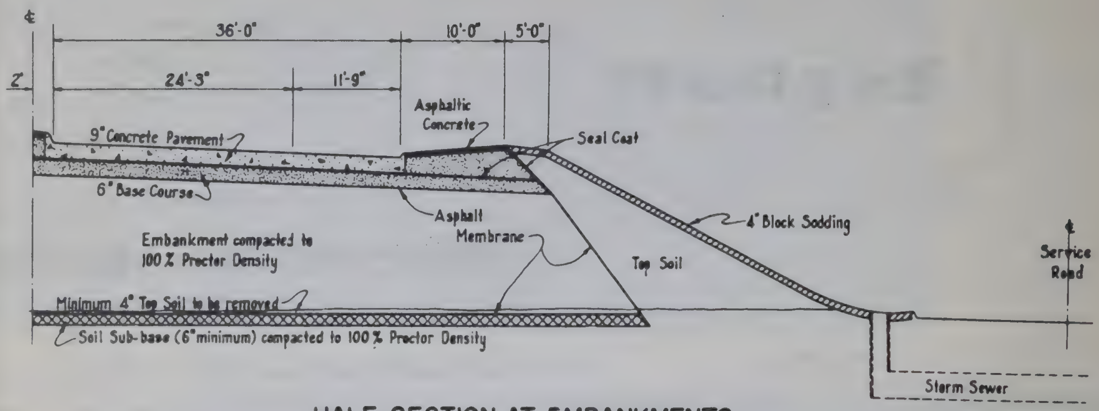
A workable construction procedure was developed on the first fill in early 1947 employing distributor application supplemented by hand sprayer on slopes. Early indications of successful performance led to continued use of these membranes and a yearly program of checking moisture, density, and strength in selected typical fills by means of continuous core borings.

The investigation has shown no significant change in any of the fills, some of which have now been in use for six years. Membranes overlaid by earth are still intact and the asphalt is very active. Membranes overlaid by sand-shell base material are intact but some reduction in activity has been observed, presumably due to chemical reaction of asphalt with calcareous constituents of the shell. The excellent performance record attained to date justifies the belief that these fills will experience many more years of successful performance.

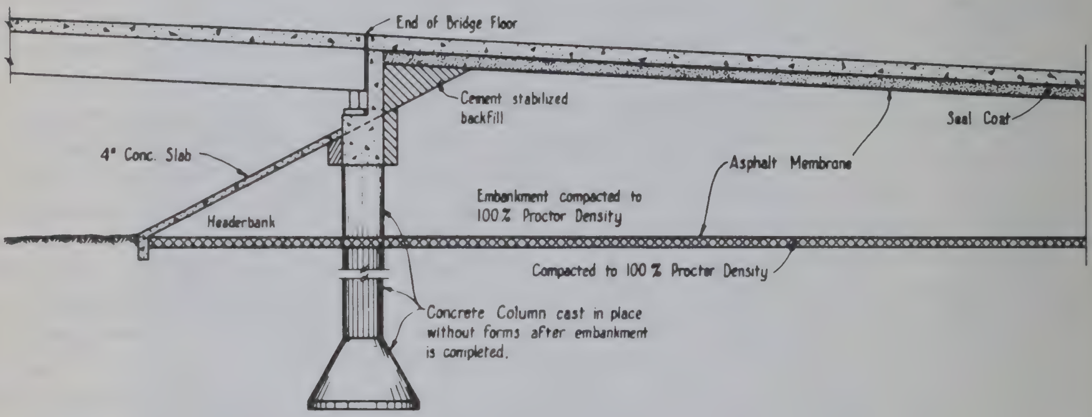
1. General: Construction of the Gulf Freeway was started in the early part of 1947. Economic considerations required that fills be constructed principally from clay soil obtained from excavation on the site. These local soils were known to be highly plastic and subject to considerable volume change under changing moisture contents. Investigation indicated that the soil could be compacted to a reasonably high density and ample strength. However, experience had shown the high densities and strength built into fills to be only temporary in many instances when the completed soil-pavement structure was exposed to the elements. Disastrous loss of strength in the soil structure often developed soon after construction, even where the soils concerned were overlaid by so-called waterproof pavements or wearing surfaces. It was concluded that some means of permanently and completely waterproofing the fills themselves was necessary, and that the means employed should be independent of any waterproofing action supplied by the pavement.

Experience with undersealing of concrete pavements with low penetration asphalt suggested the use of asphalt membranes, and after considerable study the earth-fill construction described in the succeeding paragraphs was devised.

2. Earth-fill Construction: Figure 1 shows longitudinal and cross-section views of embankments. The design employs a central core section built to 1 on 1 1/2 side slopes completely wrapped in asphalt membranes and covered with pavement, topsoil, and sod. The entire area to receive fill is first stripped of topsoil and the top six inches compacted with sheepsfoot rollers; oil asphalt having a penetration of 50 to 60 is then applied at 350 to 400 degrees Fahrenheit at the



HALF SECTION AT EMBANKMENTS


End of Bridge Floor
Cement stabilized backfill
Seal Coat
4" Conc. Slab
Asphalt Membrane
Embankment compacted to 100% Proctor Density
Headerbank
Compacted to 100% Proctor Density
Concrete Column cast in place without forms after embankment is completed.

LONGITUDINAL SECTION AT END OF BRIDGE

HOUSTON URBAN EXPRESSWAYS
TEXAS HIGHWAY DEPT.

TYPICAL EMBANKMENT SECTIONS
GULF FREEWAY

OFFICE OF THE ENGINEER-MANAGER
HOUSTON, TEXAS

FIG. 1

rate of approximately one gallon per square yard by means of an asphalt distributor. Approximately six inches of loose earth is then spread uniformly over the surface of the asphalt by bulldozers working from the ends of a strip, or motor graders working alongside a strip. No attempt is made to compact this layer for fear of puncturing the membrane. Succeeding lifts of the fill are subsequently constructed using the usual controlled moisture-density methods. All slopes are constructed wider than required and cut back by motor grader to one on 1.5 side slopes, exposing the edge of the lower membrane. Fine-grading is accompanied by sprinkling when required to maintain proper moisture content, and is followed immediately by application of the second, or upper, asphalt membrane as described above. This membrane is applied to the top surface and on all slopes to intersections with lower membrane, thus completely enclosing the entire fill. The upper membrane is placed at the same rate and in the same manner as the lower membrane, except that the distributor hand spray is used on slopes. The asphalt cools sufficiently on contact with the earth to provide essentially the same average thickness on slopes as on the other areas.

Immediately following application of the upper membrane, topsoil previously stripped from excavation areas is placed on the sides of the fill to final grade slopes of 1 on 4 or flatter. This provides a fertile bed for subsequent sodding and a cover sufficient to prevent penetration of grass roots through the upper membrane on the side slopes. The upper membrane on the top surface of the fill is covered immediately after application with whatever base material is specified by the contract. A sand-shell mixture was used on most of the construction referred to in this report.

The upper membrane at the end of the fill supporting the bridge abutment is given a thin cover of earth before placement of the four-inch concrete riprap slab. Where structural excavation for the abutment necessarily penetrates the upper membrane, a wet mixture of cement, sand, and shell is used as backfill. Recent practice has been to slope the structural excavation so that the upper membrane can be replaced by hand sprayer before the backfill is placed. Approximately 380,000 cubic yards of embankment were constructed in this manner for the Gulf Freeway. The fills average ten feet maximum height, are 60 to 200 feet wide, and total approximately two miles in length.

3. Early Field Observations: The successful accomplishment of this type of construction on the first few fills constructed on the Gulf Freeway, and the apparent effectiveness of the resulting membranes, was encouraging. However, since it was on entirely new use of asphalt in highway construction, it was thought advisable to inspect the membrane installations wherever possible during subsequent construction operations and to take every opportunity to evaluate their effect, if any, on moisture-density conditions in the soil. Some of these early observations are described briefly in the following paragraphs.

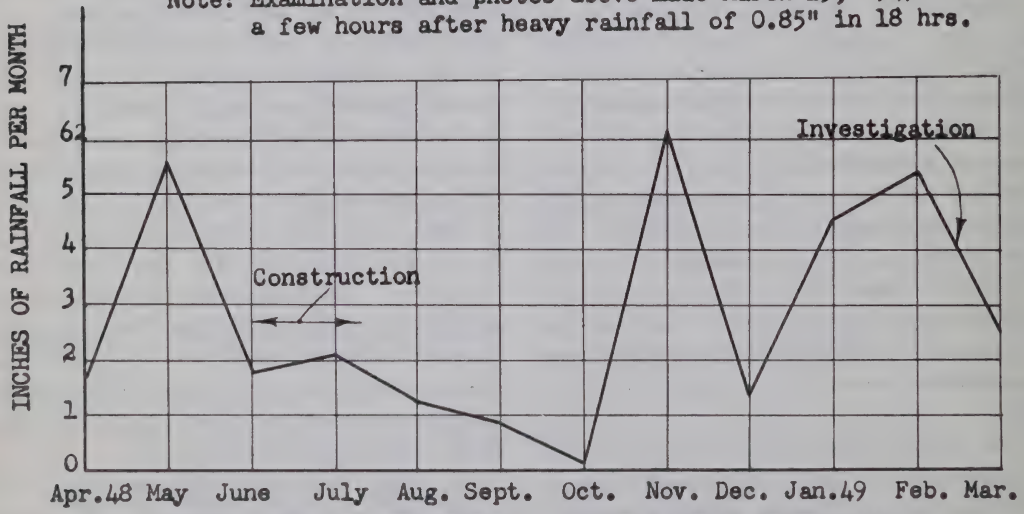
A. Inspection and Sampling in Abutment Foundation Holes: Figure 1 shows the drilled and under-reamed type of abutment foundation used almost exclusively on the Gulf Freeway. Holes for these circular footings are 30 inches in diameter and are drilled through the entire depth of fill into the natural ground below, affording excellent opportunity for visual inspection of the fill and membranes a few months after their placement. Such inspections showed the membranes in the earlier fills (as also in all later fills) to be easily located, continuous, and of surprisingly uniform thickness. The natural ground was easily identified a few inches below the lower membrane and usually became softer and wetter at about eight inches below the lower membrane. No voids or loose, uncompacted material were found in the first (unrolled) lift above the lower membrane, indicating that the practice of prohibiting rolling on this first lift was sound. Samples taken at two-foot intervals from the exposed sides of a typical hole showed moisture contents and densities in the field to be essentially as constructed.

B. Sampling Under Median Strips: The upper part of Figure 1 shows a half-section at embankment. The four-foot-wide median strip for separating opposing traffic was a flexible-type pavement on all of the earlier projects. Being located at the center line of the expressway, these median strips afforded a convenient means of checking the central portion of the earlier fills at some distance from the abutment. In July, 1948, approach fills for five structures were sampled

Top surface of exposed membrane under 6 inches of sand-shell only.

Membrane peeled back after cutting, showing condition of membrane and underlying fill.

Note: Examination and photos above made March 15, 1949
a few hours after heavy rainfall of 0.85" in 18 hrs.



TEXAS HIGHWAY DEPARTMENT HOUSTON URBAN EXPRESSWAYS

EFFICIENCY OF UPPER ASPHALT SUBGRADE MEMBRANE
WEST APPROACH FILL - WAYSIDE DRIVE OVERPASS

FAP UI 32(4), Contract V US Highway 75 Harris County
Office of the Engineer-Manager Houston, Texas

Fig.2

by means of test holes through the median strips at a distance of 50 feet from each bridge end. The fills were from six to eleven months old at the time. Results of tests on these samples were compared with similar data taken during construction. The following table summarizes the results:

Structure	Approach	% Moisture During Construction	% Moisture July 1948
Lombardy St-HB&T R. R.	East	27	27
	West	25	25
Calhoun Rd.-HB&T R. R.	East	25	24
	West	20	19
St. Bernard St.	East	17	21
	West	19	20
Scott St.	East	15	18
	West	23	20
Velasco St.-IGN R. R.	East	20	21
	West	17	16
	Average, 10 fills	21	21

The table indicates essentially no change in moisture between time of construction and sampling.

C. Upper Membrane Under Sand-Shell Cover: Generally speaking, the Gulf Freeway was built in short complete sections, each adding from one-half to one mile of usable expressway to the system. In some instances, however, earth fills were necessarily built a year or more in advance of paving and structures in order to balance cut and fill quantities on each contract. In such cases the top surface of the fills was exposed to the weather with only a few inches cover of sand-shell base material. The first case of this kind was a group of three fills constructed in June and July, 1948, and representing approximately 45,000 cubic yards of embankment. Approximately four months of subsequent very dry summer weather were followed by a comparatively wet fall and winter season. The condition of the upper membranes and earth fill immediately below the membranes were determined the following spring by removing the sand-shell cover and sections of upper membranes.

In all cases the membrane was intact and had to be cut and peeled back to expose the underlying fill. The appearance and texture of the latter was in all cases essentially the same as it was immediately after construction. Figure 2 shows photographs of the exposed upper membrane and underlying fill as it appeared on March 15, 1949, a few hours after nine inches of rainfall had fallen over a period of eighteen hours. A monthly rainfall chart for the period concerned is also shown on the same figure.

Samples of each fill were tested immediately under the membrane for density, moisture content, and air voids. Figure 3 shows the results of these tests compared with similar tests made during construction. The differences are very small, of positive and negative sign, and probably well within the accuracy of the tests themselves. It was concluded that the upper membrane with six-inch sand-shell cover was sufficient protection to the fills during such periods of exposure.

D. Sampling in Fills Under Pavement Load Tests: Another early opportunity to check performance of asphalt membranes arose in connection with a program of plate load tests for field checking of pavement design assumptions.

Several of these tests were located in pavement sections supported by fills, and test holes were made through the sand-shell base course and several feet into the underlying fill at each test location. The upper membrane was found intact in all of these test holes, and the fill in good condition. Tests of cores from these holes made in

TEXAS HIGHWAY DEPARTMENT HOUSTON URBAN EXPRESSWAYS

MOISTURE-DENSITY CONDITIONS IN EARTH FILL UNDER ASPHALT MEMBRANES COVERED WITH MINIMUM 6 INCH SAND-SHELL

CONDITIONS AND DATES	APPROXIMATE STATIONS	PERCENT MOISTURE	DRY DENSITY IN PERCENT OF PROCTOR*	PERCENT AIR VOIDS
West Approach - Wayside Drive Overpass				
Construction, June & July 1948	175 to 177+50	16.1	104	8.5
Eight months after Construction, March 1949	176+50	17.7	106	4.0
Difference		+1.6	+ 2	-4.5
East Approach - Wayside Drive Overpass				
Construction, April & May 1948	184 to 185	16.9	105	5.5
Ten months after Construction, March, 1949	183 to 184+50	16.4	107	4.5
Difference		-0.5	+ 2	-1.0
WEST Approach - Brays Bayou Bridge				
Construction, April & May 1948	194+50 to 195+25	15.6	104	8.8
Ten months after Construction, March 1949	194 to 195+50	16.2	106	5.3
Difference		+0.6	+ 2	-3.5
Average of all three fills, immediately under membrane				
Construction, April thru July'48		16.2	105	7.6
Eight to ten months after Construction, March 1949		16.8	107	4.6
Difference		+0.6	+ 2	-3.0

*Maximum dry density in pounds per cubic foot by Standard Proctor Compaction Test, AASHO Method T-99-38.

Fig.3

December, 1947, showed moistures and densities essentially the same in each case as field control tests made on each lift during construction in June, 1947.

4. Annual Observations and Test: The above described observations and tests furnished conclusive proof of the efficient performance of the asphalt membranes for periods of time up to one year, and gave sufficient assurance of their continued performance to warrant specifying them in all future work by this office.

However, the ultimate objective sought by the Engineer-Manager was full protection of fills for the life of the Expressway; hence a definite program of long-range observations and tests was needed to furnish continuing information on membrane efficiency from year to year. The program adopted consisted of continuous sampling in core borings on eight selected typical fills, once each year. The test holes on any one fill are made as close to each other as possible so that the initial soil conditions would be approximately uniform in each test section.

The borings are located near the bridge ends to attain maximum height of fill and on or near the asphaltic concrete emergency parking lanes to prevent interference with traffic on the expressway.

The eight fills are approach embankments for four structures. One of these structures is a bayou crossing at the south end of the expressway; the embankment on the south bank of the bayou was constructed by another office of the Texas Highway Department and does not have the membrane protection. Its companion fill on the north bank was constructed by this office with the membrane protection. Soil conditions are similar on each side of the bayou and the soil compaction requirements were the same for each embankment. Both of these fills are now only a few years old and no conclusions can be drawn as yet, but in time, observations on these two fills should furnish an interesting and valuable comparison.

5. Results of Annual Sampling and Testing: Tests of samples from the continuous core borings furnish detailed records of the moisture content, density, and shear strength in the test fills and underlying ground from year to year. At least 500 moisture and density tests have been made and possibly 200 shear strength tests, in addition to approximately 250 moisture and density tests during construction. These records are analyzed by averaging the respective test results for each date of sampling in each layer of soil, and the average values plotted against time. Figure 4 shows a typical plot of average conditions found at one of the earlier fills in:

A. The embankment core

B. The compacted subgrade immediately under the lower membrane

C. The natural, uncompacted subgrade underlying the compacted subgrade layer

D. Natural, uncompacted soil in level ground in the vicinity of the same fill.

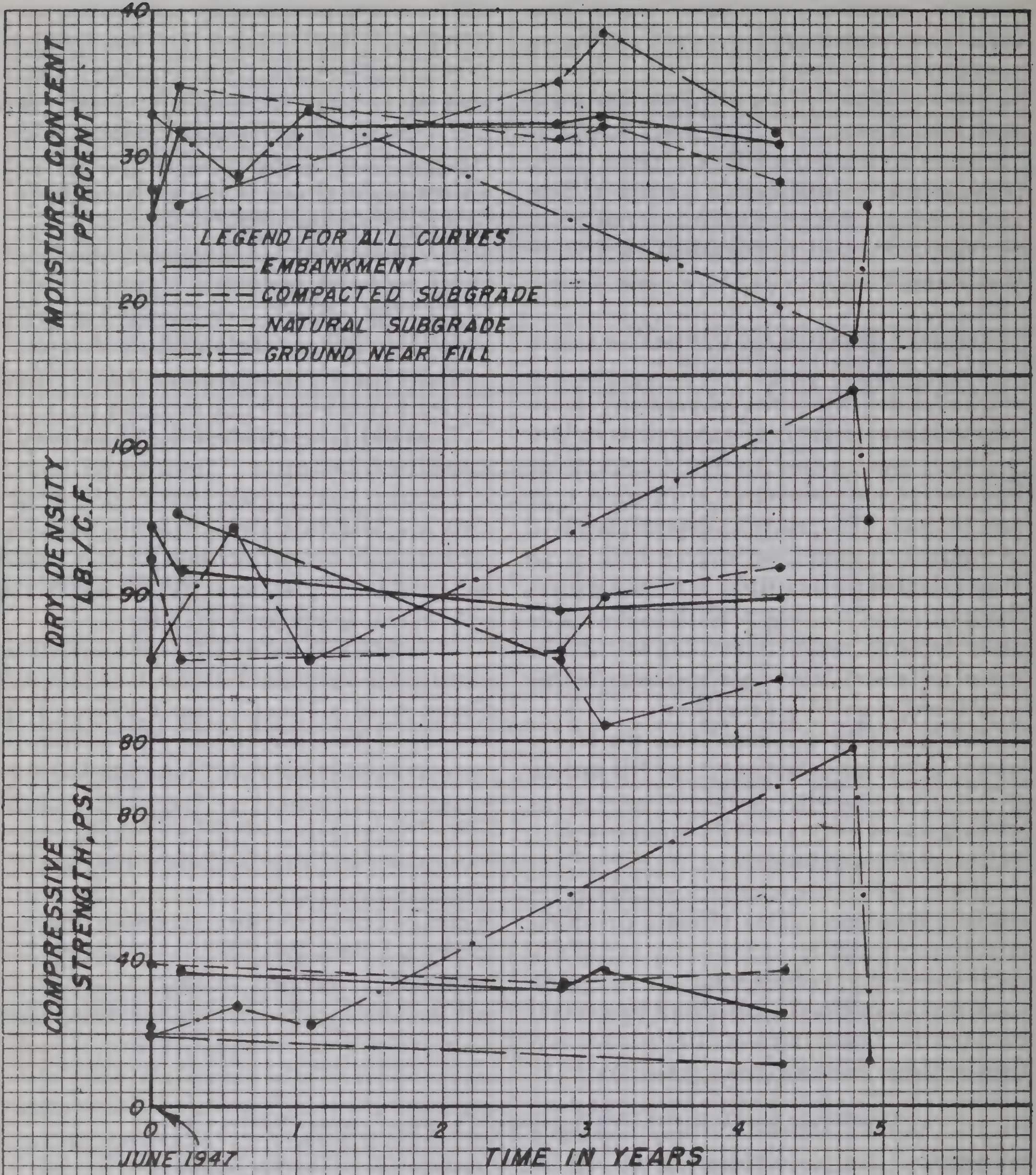
The stabilizing effect of the membranes is very clearly indicated. The minor variations found from year to year in the embankment core are less than those found in the compacted and natural subgrade below the fill and considerably less than those found in the natural soil in the same vicinity.

It is to be noted also that the variations noted in the subgrade soils have occurred at distances of 40 feet or more inward from the toe of the final slopes. The variations are appreciable but much less than found in natural level ground in the vicinity of the fill. This condition has been noted on the four oldest test fills. Sufficient time has not elapsed for similar records on the other fills. It can be concluded that the cover afforded to the subgrade by the four older fills has inhibited or reduced seasonal variations in soil conditions, but has failed to prevent such variations. This conclusion, if subsequently found to be general, is of particular importance in that it indicates the necessity for the lower membrane. Top coverage alone apparently would not achieve the desired results.

6. Observation During Sampling Operations: In addition to the year-to-year data on actual soil conditions shown by tests of the samples, the program also affords an opportunity each year to examine the membranes themselves and to visually examine the texture and condition of the embankment core as compared to the subgrade soils.

This is considered of equal or greater importance than the actual test results. A brief summary of these observations follows:

A. Upper Membrane: A few of the test holes have been made at sufficient distance



TEXAS HIGHWAY DEPARTMENT HOUSTON URBAN EXPRESSWAYS

AVERAGE SOIL CONDITIONS

EAST FILL OF STRUCTURE NO. 6 AND VICINITY

OFFICE OF THE ENGINEER-MANAGER HOUSTON, TEXAS

FIG. 4

from the roadway to be outside the limits of pavement base material. In such cases, the upper membrane is covered with two feet or more of topsoil. In all such cases the upper membrane has been found intact and the asphalt still active. The thickness of the upper membrane in test holes intercepting the side slopes is generally found to be some less than in those closer to the roadway.

However, as previously mentioned, most of the test holes have been located closer to the roadway where the top surface of the fill is horizontal and the upper membrane is overlaid by sand-shell base material. Numerous small pieces of flat shell are usually found embedded in, or stuck to, the membrane so that considerable hand-picking is necessary to remove sufficient of these to expose the black top surface of the asphalt membrane. This has been found intact in all cases and has a dull black surface that does not appear to be particularly active or "alive." When sections of the membrane are removed and viewed from the side, a dull film or mat one-sixteenth inch or less in thickness can be observed, indicating that the asphalt and base material have combined physically and/or chemically into an inert mass. It is quite likely that the calcareous constituents of the oyster shell have reacted chemically with the asphalt to produce the dull color and inert appearance. The dull mat is usually underlaid by shiny black active asphalt sufficient to give the entire membrane a total thickness of one-eighth to one-fourth inch.

Specimens of such upper membranes and underlying fill material have been preserved in the laboratory for observation. In many of these the active asphalt on the bottom of the membrane has melted under the influence of the warm laboratory atmosphere and has flowed out from under the upper mat, which remains in its original position in spite of the resulting void spaces left by the escaping asphalt.

It is concluded that, in spite of considerable loss of activity, the upper membranes under shell base material still function as a water barrier and have considerable waterproofing ability.

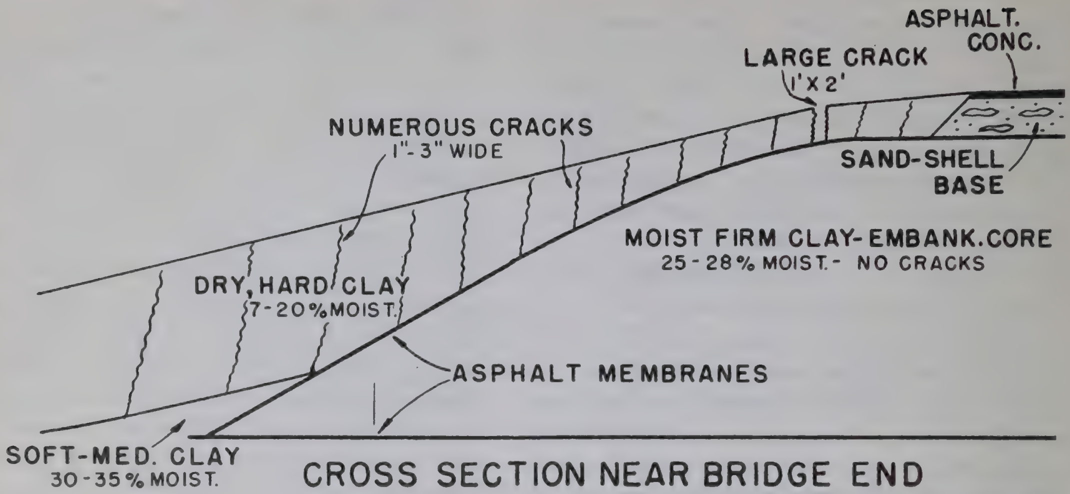
B. Lower Membranes: In all cases the lower membranes have been found to be in proper position and the asphalt fully active. In the continuous sampling procedure a sampling tube is advanced about eighteen inches, then withdrawn with the sample and the hole reamed to the bottom. Succeeding samples are taken in similar manner, providing a complete series of continuous undisturbed samples of the ground. Hence, the lower membrane will be found lying horizontally in one of the samples and by measuring the depth of the hole and the position of the membrane in the sample, a very accurate location of the membrane is made. In a few instances the membrane was at the top or bottom of the sample and was partly destroyed. The probability of such occurrence is so small that practically all of the lower membranes have been recovered intact.

Short sections of samples containing membranes have been preserved by sealing them inside transparent lucite tubes. The samples were trimmed to the proper diameter, then pushed into the tubes. On many of these, the asphalt smeared the inside of the tube badly, and in most cases considerable asphalt inside the sample has subsequently melted, flowed out, and run down the sides of the tube. In other cases the soil has been trimmed from above and below the membrane and the latter found to be from one-sixteenth inch to one-fourth inch thickness and quite tough and pliable. In the field, the membranes are detected in the samples by a thin black line exposed on the side of the sample. This line is usually quite definite and continuous, indicating complete coverage in the ground.

All of these observations indicate that the asphalt in membranes separating layers of clay are very active and has not changed its characteristics appreciably since its application.

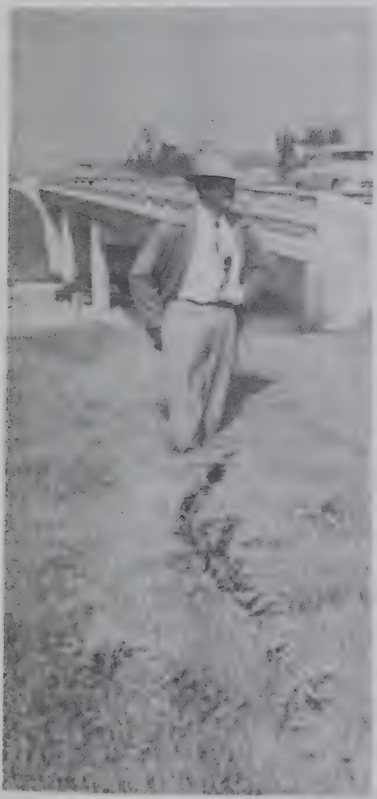
Quite frequently traces of asphalt are found in small voids and cracks above or below the membrane, thus effectively sealing such spaces.

C. Appearance of Soil: The texture, consistency, and appearance of the soil between membranes has been found to be essentially the same as when constructed. In a few cases horizontal planes of weakness were found that were sufficient to result in breaking the sample during handling. These planes were presumably boundaries between lifts. Small wet voids observed above such weakened planes were probably

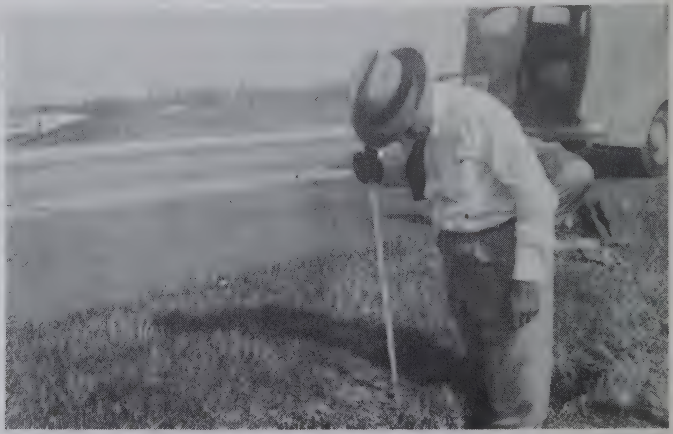

ASPHALT. CONC.
LARGE CRACK 1'X 2'
NUMEROUS CRACKS 1"- 3" WIDE
SAND-SHELL BASE
MOIST FIRM CLAY-EMBANK. CORE 25 - 28% MOIST.- NO CRACKS
DRY, HARD CLAY 7-20% MOIST.
ASPHALT MEMBRANES
SOFT-MED. CLAY 30-35% MOIST.

CROSS SECTION NEAR BRIDGE END

VIEW INTO CRACK AND TEST PIT-
MEMBRANE PEELED BACK FROM
EMBANKMENT LOWER LEFT OF PICTURE



CONSTRUCTION ENGINEER
IN CRACK



ENGINEER-MANAGER IN CRACK

SHRINKAGE CRACK INVESTIGATION-STR. 13

FIG. 5

dry soil at the bottom of a lift that was not sufficiently wet during construction to allow proper compaction. The dry nature of the soil and the presence of voids has apparently drawn moisture from the surrounding soil. Such instances are rare however, and usually a change in color or consistency is the only evidence of lifts shown by the samples.

Particular attention is given in the field to examination of the soil immediately under the top membrane. This has always shown the soil to be firm, moist, and slightly pliable-essentially the same as constructed. Immediately below the lower membrane, the older fills show a tendency to be some softer and wetter than when constructed, and quite frequently there is a change to much softer and wetter soil when the undisturbed natural ground is reached. The latter ground is probably in very near its original condition, although as mentioned previously, the test results do show some variations in soil conditions in the natural ground below some of the test fills.

7. Protection Against Soil Shrinkage: An excellent demonstration of the efficiency of these membranes occurred late last summer after a long dry period. A crack 80 feet long with a maximum width of one foot developed along the crown line of an embankment. It extended down to the upper membrane, which is about two feet below the surface at this point. Figure 5 shows a sketch and photographs of the conditions found. The upper membrane was easily identified at the bottom of the crack and several pits were excavated to expose a larger area of the membrane. Sections of same were cut and peeled back to allow inspection of the embankment core. In all cases the membrane was intact and alive and showed complete coverage. The soil below the membrane was free of cracks and in the same firm, moist condition as constructed. Tests on samples showed moisture contents and densities in the fill to be essentially 100 per cent Proctor immediately below the membrane, and to vary from 7 to 35 per cent in the soil above the membrane.

In this case, the membrane stopped the shrinkage crack at the top of the embankment core and definitely prevented loss of the moisture of compaction and subsequent loss of stability in the embankment core.

8. Conclusions:

A. Evidence from every means of observation conceived by this office indicates that the asphalt membranes separating layers of clay are intact, the asphalt active, and the coverage complete. The observations cover a period of five years in some cases.

B. By similar evidence upper membranes covered with sand-shell base material are intact and the coverage complete. The upper surface of the asphalt is now inert, but the membranes continue to function effectively as water barriers.

C. Only minor variations in average moisture, density, and strength have been observed in the embankment cores during the five-year period.

D. These variations are somewhat smaller than those found in the natural soil under four fills, and considerably smaller than similar variations in level uncompacted ground in the immediate vicinity.

E. The favorable showing during the first five years of observations justifies the belief that the membrane will afford effective protection for many more years.

● ● ●

Knowing how and why things tick is an important part of our growth. For instance, the more we know about a particular piece of machinery, the better care we can give it. But, in our search for "know how," we have to exercise some care and avoid changing or experimenting "just to see what will happen." We must be able to differentiate between a bona fide service adjustment and harmful tampering.

"Comments From the Traveling Public"
OVER THE HIGHWAYS

. . . Lack of signs signifying 60 mile highway speed can be resumed . . .

L. M. Klein
Tulsa, Oklahoma

. . . Direction signs are a little too close to intersections . . .

Malibu, California

. . . Highway signs in some cities had highway numbers pointing both ways without giving name of city. As strangers we did not know east, west, south or north direction.

R. S. Sknoch
Independence, Wisconsin

. . . There is too frequent use of 30 mile speed limits - believe your speed limit system can be revised to meet your wonderful straight roads . . .

A. W. Crenshaw Jr.
Virginia Beach, Virginia

. . . Very poor highway markings in cities. Corners and turns in cities should be marked before approaching turn rather than at the turn . . .

Sioux Falls, South Dakota

. . . You have invisible, illegible and poorly placed directional signs, especially in cities and towns . . .

H. Teller
Charleston, South Carolina

. . . We didn't like the beer cans along the road. Beautiful highway cluttered up with beer cans . . .

F. H. Lemper
Ft. Wayne, Indiana

. . . There was no center stripe on some highways . . .

St. Louis, Missouri

. . . Too many traffic lights in smaller towns . . .

Malvern, Iowa

. . . One road for about 50 miles was littered with beer cans . . .

Carlisle, Indiana

. . . Why does the rail on your causeways and bridges have to be placed at the exact height to shut off one's vision . . .

Floyd Taylor
St. Johns, Michigan

. . . Some places we had no previous warning of split in routes (we followed highway numbers) . . .

Farmington, Michigan

. . . You could have more distance signs along the road . . .

Vancouver, Washington

. . . Too many stop lights in small towns at apparently unimportant intersections on through highways - why not a yellow blinking light instead sometimes? . . .

Charles H. Jeney
South Carolina

. . . The traffic signals and street markings in most of the large cities were harder to see than those in some of the other states we traveled through . . .

Mr. & Mrs. Walter Schuenhoff
Clarion, Iowa